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REPORT TO CITES:

CITES-Listed Species at Risk from Illegal Trafficking in Bushmeat; Results of a 2012 Study in Switzerland's International Airports

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ABSTRACT

Illegal meats arrive daily in Europe's airports and some of this includes meat from wild species. The trade in wild meat or “bushmeat” for human consumption is an often overlooked, but no less harmful aspect of the illegal trade in wildlife products. Due to the black market nature of the trade, the smuggling of wild meats is difficult to track and deter, but can have a devastating impact on animal populations of trafficked species. It also has serious implications for human public health by increasing the risk of emergent disease introduction to naïve populations.

This study describes the illegal trade in bushmeat arriving at the two largest international airports in Switzerland; Flughafen Zürich and Genève Aéroport over a one year period in 2012. Our study is the first of its kind to characterize and quantify confiscations of bushmeat smuggled into Switzerland for human consumption. The majority of bushmeat arriving in Switzerland originates in West or Central African countries, with Cameroon being the most frequent country of origin. While the meat originates in Africa, most arrives on transit flights departing from within Europe. Confiscations of bushmeat were significantly larger than other types of meat confiscations. Bushmeat sometimes arrives as whole or partial carcasses, but was most often pieced, making species recognition difficult. The use of mitochondrial DNA techniques allowed us to identify those species at risk from the trade. Over *one-third* of the species we found arriving as bushmeat in Swiss airports were CITES-listed species, and included pangolins (*Manis* spp.), primates (*Cercopithecus* spp.), duikers (*Philantomba monticola* and *Cephalophus dorsalis*), tortoises (*Kinixys erosa*), and small carnivores (*Aonyx capensis*). A number of other species arrived as bushmeat, including rodents, wild pigs and other ungulates, reptiles, birds and invertebrates.

The international movement of wild meat is not well documented or quantified. Information from airport searches by Swiss Customs agents during controlled exercises meant to monitor illegal trafficking were used to provide a rough estimate of the scale of the bushmeat problem in Switzerland, suggesting that even in this one, small European country, at least 40 tonnes are arriving annually and likely more - a model of bushmeat smuggling created with University of Bern is currently in progress that suggests between 500 and 1500 tonnes may be arriving yearly. Illegal bushmeat imports are known to occur in most developed world ports of entry, and are likely to be contributing to the problems of species conservation in source countries. However, illegal meats coming into European ports of entry are routinely destroyed to reduce the risk of disease introduction and important information about species at risk from the trade is being lost in this process.

The trade in wild meat is occurring on a global scale, and is likely to be on the increase as it provides lucrative profits for smugglers with very few consequences for being caught. More effective policies and penalties for bushmeat smuggling in Switzerland, as well as in source countries, are a necessity. We discuss the issues in regard to bushmeat smuggling into developed world ports and outline a number of possible avenues for strengthening detection, deterrence and prosecution of bushmeat smugglers.

Key words: bushmeat, wild meat, species identification, mitochondrial DNA, wildlife trafficking, meat imports, smuggling, Customs, airports, Switzerland, Africa, emergent disease, policy, primate, pangolin, duiker, tortoise, small carnivore

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INTRODUCTION:

INTRODUCTION

Bushmeat: An Underestimated Aspect of the Illegal Trade in Wildlife Products

In this report, we consider the often overlooked problem of the bushmeat trade – or more specifically, the international, illegal trafficking of wild meat for consumption. The term 'bushmeat' was first used to describe meat originating from Africa, where the forest is referred to as 'bush', and hence 'bushmeat' describes the meat of any wild species coming from an African forest. This term has since been adopted for ***any non-domestic (i.e. wild) species harvested for food*** (Nasi et al 2008), and the expressions 'wild meat' or 'exotic meat' are often used synonymously, as they are thought to be less region-specific (Milner-Gulland et al 2003). For this study, we defined bushmeat as *any type of wild meat for consumption (excluding fish), and coming from any region*. This included wild species of mammals, birds, reptiles, and invertebrates that were illegally smuggled as food items in passenger luggage, cargo and mail arriving in Switzerland via two ports of entry; Flughafen Zürich and Genève Aéroport.

Wild meat can come from a number of regions; but in particular, Sub-Saharan Africa and South-East Asia are known to be the major supply regions (UNODC 2010; Haken 2011). Both Africa and Asia still have large, undisturbed tracts of forest where some of the world's most unique biodiversity remains (Myers et al 2000; Groombridge and Jenkins/UNEP-WCMC 2002). Wildlife coming from these regions is therefore at the greatest risk from illegal trade, including the use of wild animals as meat for human consumption. The direction of flow in legal and illegal wildlife trafficking is from biodiverse areas to more developed nations, most notably, China, USA, and the EU are the largest consumers of wildlife products (IFAW 2013; Haken 2011; Engler and Parry-Jones 2007; Ellis and Turner 2007; Milieu 2006; TRAFFIC 2013a).

The trade in wild meat was first documented by investigative journalist and photographer, Karl Ammann (Ammann 2013), who is credited with bringing the issue to the attention of the scientific community in the 1990s through photographs of 'bushmeat' in Africa (Ammann and Pierce 1995; Rose 1996; Ape Alliance 1998; Ammann 2000; Rose et al 2003; Furniss 2005; Faris 2007). His work featured the Great Apes (Ammann 1995; Peterson and Ammann 2004) and inspired bushmeat awareness campaigns in zoos in Europe (EAZA 2013; Carroll 2002, 2009; EAZA 2010) and the U.S. via the Bushmeat Crisis Task Force (AZA 2013; Rose 1999; Bailey 2000; Kohn and Eves 2006; Eves et al 2008; BCTF 2009). In the past 10 years, however, there has been decreasing attention to the bushmeat issue and little effort to investigate the trade in wild meat in the majority of the developed world[1]. Most studies of the bushmeat trade occur in Africa (Redmond et al 2006), with very little information available about *illegal bushmeat exports out of Africa*, and *their subsequent import into European and other developed world countries*. However, illegal wildlife confiscations, including bushmeat, are a known entity at many major airports and other ports of entry in Europe and other developed world countries and internal statistics on these confiscations of wild meat do exist. But these records are not typically opened to the public

[1] Ongoing efforts to monitor the bushmeat trade in Europe include the Zoological Society of London's (ZSL) Institute of Zoology Bushmeat Researche Programme (ZSL 2013a) and the U.K. Bushmeat Working Group (UKBMWG), which holds annual meetings of U.K. government officials and other interested parties to discuss the trade in bushmeat (ZSL 2013b; UKBMWG 2013). In the U.S., the Bushmeat Crisis Taskforce disbanded in 2009 (BCTF 2009), but a program by Brasheres (2013) at UC Berkeley has been compiling information on the dynamics of bushmeat black-markets in North America and Europe over the past several years. The Convention on Biological Diversity's Liaison Group on Bushmeat is an international effort by UNEP to develop policy recommendations for sustainable use and conservation of bushmeat species inside Africa (Nasi et al 2008; CITES 2011a; CITES 2011b). Besides these efforts, there is little attention to the bushmeat issue in Europe and other developed world countries.

and are therefore under-utilized by conservationists and policy-makers, and there have been few attempts at scientific study of the bushmeat trade inside Europe.

The only systematic study of the scale and quantity of bushmeat coming into a major European port is by Chaber et al (2010), which look at bushmeat arriving at the Charles De Gaulle Airport in France in 2008. The focus of the Chaber study was on *direct Air France flights from West and Central Africa* and results showed that 8 to 16% (on average 7%) of passengers on these flights were smuggling bushmeat in their luggage (Chaber 2009, 2010). Chaber's study found a range of species, including many of the same species found in the study described in this report, and including a number that are protected under the Convention for the International Trade in Endangered Species (CITES). Chaber estimated that approximately 5 tonnes of bushmeat *per week* is smuggled into France via Paris' Roissy-Charles de Gaulle airport in personal baggage alone. The extrapolation from this – of 270 tonnes of bushmeat smuggled *per year* into this one airport in France - is a staggering but very real figure for threatened and endangered species. Studies of the international trade in bushmeat such as Chaber's, which described and quantified the amount of illegally trafficked bushmeat, are rare, but are a necessity in today's world of rapid, global movement of goods. Our study describes the bushmeat trade in Swiss Airports and was modeled after the Chaber study, with the aim to compare results and to encourage similar studies in other developed ports in Europe and worldwide.

The Existing Framework for the Trade in Wild Meats

The global trade in vulnerable, threatened and endangered animal products, including game meats, is regulated by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). CITES is an international agreement between governments, conceived of in the 1960s, when the threat to wildlife from illegal trafficking was first recognized, and put in place in 1973 to regulate this trade. CITES currently has 178 member states (CITES 2013a), and the treaty's stated aim is *"to ensure that international trade in specimens of wild animals and plants does not threaten their survival"* (CITES 2013b). CITES-listed species are those species of animals and plants that are protected against over-exploitation in international trade. Protection comes via the CITES appendices (I, II and III), which include approximately 5,000 species of mammals, birds, reptiles, invertebrates, and fish. A CITES Appendix I listing is the most restrictive and bans trade entirely, whereas Appendix listings II and III allow some trade, with proper documentation and permits issued from the credible, government authority of a CITES member state (CITES 2013c).

Despite the well-intentioned goals of CITES and national policies, protection for vulnerable species is not always adequate within the existing framework. CITES regulations result in protection for species *via limiting the numbers of legal imports or exports, within the context of trade*. National laws within CITES member countries must exist that protect animals against over-exploitation, and must also be enforced by that member state, which is not always the case. In regard to animal exports from wildlife range countries in Africa, corruption or mismanagement by policy makers, government officials, and others often undermines the best intentions of national and international laws and the CITES regulations aimed at protecting species in trade. The result is often inadequate protection of vulnerable species within the existing framework. And in the case of illegal smuggling of wildlife, which occurs outside of existing laws or CITES regulations, protection becomes non-existent.

In Switzerland, the Federal Veterinary Office (*Bundesamt für Veterinärwesen, FVO/BVET*) was responsible for the regulation of animal imports through January of 2014, when it merged with the

Department of Food Safety (*Bundesamt für Gesundheit/BAG*) to become the Federal Food Safety and Veterinary Office (*Das Bundesamt für Lebensmittelsicherheit und Veterinärwesen, FSVO/BLV*) [2]. The Federal Veterinary Authorities in Switzerland work closely with Swiss Customs (Eidgenössische Zollverwaltung /EZV) to prevent illegal smuggling of animal and plant products across national borders and protect humans, local livestock and wildlife from the threat posed by illegally smuggled animal products. Swiss Customs agents are on the frontline of the bushmeat issue and routinely carry out searches of passenger luggage, cargo and mail, during which all meat and milk products from outside the EU are confiscated (Swiss Customs Administration 2013). The disease risks inherent in imported animal products are the primary reason for the prohibition of meat and milk products arriving in Switzerland and the EU from third countries (EU Commission 2004; *Commission Regulation (EC) No 745/2004 of 16 April 2004 laying down measures with regard to imports of products of animal origin for personal consumption*) (European Commission 2010, 2013). An agreement between Switzerland and the EU harmonized Swiss food laws with existing EU regulations to strengthen border controls in regard to the import of agricultural products and food of animal origin (Swiss Confederation/Schweizerische Eidgenossenschaft 2002; BAG/Bundesamt für Gesundheit 2010) and a number of additional amendments to EU Regulations and Swiss laws pertaining to imports from third countries for all products of animal origin, including meat, exist (FVO/BVET 2007, 2008, 2009, 2013a, 2013b; UNEP-WCMC 2013a). However, even in developed world countries such as Switzerland, protection of species is not always adequate within these regulations, such as is the case with bushmeat. For example, national policies in place to protect humans from the potential disease risks inherent in meat imports do not necessarily protect those species vulnerable to the bushmeat trade.

Cause for Concern: The Overexploitation of Vulnerable Species

The international trade in bushmeat and other animal products is of concern because it is contributing to the overexploitation of species from source regions. Unique species and ecosystems are vulnerable to this trade, especially the forests of West and Central Africa which is currently the most heavily exploited region in regard to wild meat consumption (Fa et al 2002). This includes the Congo basin of Central Africa (Fa et al 2003; CBFP 2010), the Guinean Forests of West Africa (Oates et al 2004), the Cross-Sanaga forest region of Nigeria and Cameroon (Fa et al 2006), and the island of Bioko (Hearn and Morra 2001). These regions are made more vulnerable by also having growing human populations which rely on bushmeat as a protein source, use unsustainable hunting practices and have limited farming cultures. An intercontinental comparison of bushmeat consumption by Fa et al (2002) estimated that over 5 million tons of mammals feeds millions in the tropics, with 4.9 million tons of this coming from Afrotropical forests. The forests of the Amazon Basin in South America encompass another large region of tropical forest also known to be exploited for their wildlife, including wild meat for consumption (Fa et al 2002; Rushton 2005; Altherr 2007; Giovanni 2006; Renctas 2001). However, it was estimated that while 60% of mammalian species in the Congo basin forests were harvested unsustainably for their meat, few in the Amazon basin were (Fa et al 2002). Livestock farming may provide alternative protein sources in the Amazonian region, alleviating a dependence on wild meat, although still degrading habitat (Rushton 2005).

[2] In January of 2014, the **Federal Veterinary Office/Bundesamt für Veterinärwesen (FVO/BVET)** and the **Department of Food Safety/Bundesamt für Gesundheit (BAG)** were merged into a new **Federal Office of Food Safety and Veterinary (FSVO)/ Bundesamt für Lebensmittelsicherheit und Veterinärwesen (BLV)**. The FSVO/BLV is the new governing body for all matters pertaining to food safety, nutrition, animal health, animal welfare and protection of species in international trade within Switzerland (FSVO/BLV 2014). During 2012, the period in which this study occurred, the Federal Veterinary Office/Bundesamt für Veterinärwesen (FVO/BVET) was still in place.

Primates were used as indicator species in this study as they are some of the most vulnerable species to the bushmeat trade. Large-bodied, long-lived animals which give birth to few offspring in which they invest time and energy have slow growth rates and are therefore at higher risk from over-exploitation for their meat (Purvis 2001; Brashares 2003). Primates are of particular concern when considering life-history characteristics; they are some of the largest animals in African forests, with long periods to maturity and very low reproductive rates, typically giving birth to one offspring in which mothers must invest substantial time and energy (Gage 1998; Ross 1998; Chapman et al 1999; Kappeler and Pereira 2003; Alberts and Altmann 2003). Great apes in particular are very large-bodied and nurse offspring for a period of years, making them especially vulnerable to the dynamics of the bushmeat trade (Bowen-Jones 1998, 2002; Cowlishaw and Dunbar 2000; Isaac and Cowlishaw 2004). Despite this, the three most common animal groups found as bushmeat in most African markets are rodents, ungulates, and primates (Falconer 1990; Ntiamoa-Baidu 1997; Wilkie and Carpenter 1999; Fa et al 2005; Nasi et al 2011). Primates are sometimes even a preferred meat and hunting is known to have depleted populations in many areas and is one of the most immediate threats to primate populations (Bowen-Jones and Pendry 1999; Oates 1999; Hearn and Morra 2001; Barnes 2002; Bowen-Jones et al 2002, 2003; Grubb et al 2003; Chapman et al 2006). Close to half of the 634 known species of primates are considered endangered or threatened by the International Union for Conservation of Nature (IUCN 2013a) and all primates are listed in either CITES Appendices I or II. Finding them in Swiss airports would indicate that the international component of the bushmeat trade could be having a substantial impact on these and other vulnerable species.

Cause for Concern: The Spread of Disease Pathogens

In addition to depleting endangered wild animal populations, one of the most serious issues in regard to the import of bushmeat is the health risk it poses to humans and also to domestic and wild animal populations in the importing country through the introduction of disease pathogens. Concern about the introduction of disease is one of the primary motivators for trade restrictions (Kimball 2006; Brown 2010). Most existing regulations in regard to meat imports have to do with *known diseases of domestic animals* that, if accidentally imported in animal products, have the potential to threaten food security, such as the 2001 outbreak of Foot and Mouth Disease in the U.K. (Scudamore and Harris 2002; Thomson et al 2002, 2003; Wooldridge 2006). Of particular concern are zoonoses (i.e. diseases that can be passed between animals and humans); of the 1415 known human pathogens, 61% are zoonotic (Taylor 2001; in Cunningham 2005). In addition to known pathogens, illegal wild meat products have the potential to contain new or emerging zoonotic diseases. Emerging infectious diseases have been defined as "*infectious diseases that have recently increased in incidence or geographical range, recently been discovered, are caused by newly evolved pathogens* (Lederberg et al 1992)*, or have recently moved into new species*" (Daszak et al 2000). Because they are new, emerging zoonoses are not well-known and not yet fully studied. Therefore, the protective measures (via national health programs) to keep human and animal populations safe may not yet be in place.

Of the pathogens that cause new emerging infectious diseases, it has been shown that wildlife are the most likely source of infection (Cunningham 2005); the majority of emergent disease events (>70%) originate in wildlife (Jones et al 2008). In everyday sub-Saharan Africa and other third world countries, local people come into contact with viruses via hunting and consumption of bushmeat (Peeters et al 2002). The butchering process of wild animals for their meat is a route for transmission to occur; it exposes hunters and consumers to blood and body fluids from potentially infected wild animals where zoonotic transfer becomes possible (Wolfe et al 2004, 2005; Nayar 2009). Primates and rodents in particular are known to carry a number of viruses which can be transmitted to humans (Smith 2011). Cases have been documented of highly virulent diseases imported in live monkeys and rodents and

resulting in outbreaks and human fatalities (Marburg virus in Germany; Jahrling et al 1990; CDC 2010a; Monkeypox in the U.S.; Guarner et al 2004). Of particular concern is the Ebola virus, which erupts regularly in Africa (CDC 2010b; CDC 2014; WHO 2014) and can live for 3-4 days in infected animal carcasses (Leroy 2004b). Handling and consumption of dead infected primates has been linked to outbreaks of the disease in Africa (Le Guenno et al 1995; Formenty et al 1999a,1999b; Leroy et al 2004a, 2004b; Rouquet et al 2005; Bermejo et al 2006; Rizkalla et al 2007; IRIN 2012; Richardson 2012; CDC 2014). Also of concern in regard to primates are the Simian Immunodeficiency Viruses (SIV), which are related to HIV and have been shown to be present in primate bushmeat (Peeters et al 2002; Aghokeng 2010). A recent study by Smith et al (2011) was the first of its kind to search for viruses arriving in bushmeat in JFK airport in the United States. The study looked specifically at primate and rodent bushmeat imports and found diseases such as Simian Foamy Virus (SFV, a retrovirus similar to SIV) and primate herpes viruses to be present, and concluded that, especially in the case of non-human primates, bushmeat can be a route for pathogen transmission. Illegally smuggled bushmeat is unlikely to have been butchered or transported under the strict veterinary standards used by more developed countries and is therefore more likely to carry disease, with the potential to expose local plants, animals and humans in Switzerland to these diseases.

Airlines are a main mode of transport in modern society, and provide a vector for the rapid, international spread of diseases. One study found human movement of pathogens via trade and travel to be the most important factor driving disease emergence (Cunningham et al 2003). There are a number of examples of diseases which are known to have been spread via airlines (Pavia 2007; Mangili and Gendreau 2005) including the 2003 outbreak of severe acute respiratory syndrome (SARS), which spread across 4 continents within 3 days via global air traffic (Gaber et al 2009), the pandemic influenzas (swine flu and bird flu-H5N1; Hufnagel et al 2004) and more recently, Ebola (CDC 2014). The importation of wild animal carcasses and pieced wild meat into more developed countries such as Switzerland on a daily basis should be of serious concern. While endemic African populations may have some resistance to harmful pathogens, native populations of humans and animals in other regions may not.

The Bushmeat Trade in Europe; Previous Studies and this Study

Because of the disease risks inherent in all meat products, confiscations of bushmeat and domestic meats in Switzerland are treated similarly; all confiscated meats are considered biological waste and are disposed of through incineration at a bio-safe facility. When bushmeat or other types of meat are confiscated, especially in the case of pieced meat, it is often difficult for customs officials to recognize species. Meat is often cut into pieces for ease of transport, and in the case of bushmeat, smoked as a means of preservation, obscuring recognizable features. As a result, meat from wild animals may be difficult to distinguish from meats originating from domesticated species, and also especially difficult to identify to species. In the current framework, upon arrival in Swiss airports, if not recognized as such, an endangered or CITES-listed species could be immediately disposed of along with all other, non-descript and domestic meats and meat products. Switzerland may be, in essence, throwing out the monkeys with the meat; disposing of endangered and vulnerable species as generic, bio-hazardous waste, while information valuable to the conservation of these species is being lost in the process.

The purpose of our study was to first identify what species are at risk from bushmeat smuggling into Swiss airports and, second, to quantify how much bushmeat may be coming into Switzerland annually. This report presents the complete results of the study. To identify species, we extracted tissue samples from confiscated meat products for DNA analysis. In the Chaber study in Paris (2010), species were identified by their morphology (i.e. identifications were based on the appearance of whole carcasses or a later examination of bones present in carcasses or pieces). This means that only grossly recognizable

carcasses and/or bones were identified. The use of mitochondrial DNA is currently the gold standard for species identification (Hsieh et al 2001; Tsai et al 2007; Tobe et al 2010). In this study, we utilized the most accurate standardized DNA wildlife forensic techniques to identify species (Morf et al 2013) and this report includes the species results from tissue samples opportunistically collected from all bushmeat confiscations seized from passenger luggage from September of 2011 through January of 2013 in Swiss airports. Additional information came from tissue samples collected from all confiscations of meat and meat products on 'control day' exercises carried out during 2011 and 2012, in cooperation with CITES, the Swiss Federal Veterinary Authority (FVO/BVET) and Swiss customs officials at the Zürich and Geneva International Airports. These exercises allowed us to collect data that could be used to create a model to estimate the amount of bushmeat coming into Switzerland annually. In addition to data collected during the study, the Swiss Customs Administration gave us access to Customs Records of all illegal meat and milk products confiscated from airline passenger luggage at Zürich and Geneva's International Airports from 2008 through 2012, including those confiscations identified or suspected of being bushmeat. These records were used to support the results of this study.

METHODS:

Bushmeat Metrics

METHODS

I. Data Collection during the Study

A number of data sources were utilized in this study, including data opportunistically collected from September 2011 through January of 2013 from confiscations suspected of being bushmeat by Swiss Customs, data collected during five 'control days' exercises to monitor illegal wildlife imports of interest to CITES and FVO officials, and finally, data provided by Swiss Customs for the period of 2008 through 2012 of all meat and milk products confiscated in two Swiss Airports; Zürich Flughafen and Genève Aéroport.

Swiss Airports - Confiscation and Search Protocols

In this study, confiscations of illegal meat products came from passengers on flights arriving at either Flughafen Zürich or Genève Aéroport. On any given day, customs agents in these two airports conduct searches of passenger luggage and confiscate *all* meat (and milk) items, of which some proportion is bushmeat. For searches, passengers are picked randomly, or according to confidential customs agents search criteria, as they exit the airport. Meat and milk items are not confiscated from passengers travelling *within* European Union countries; official documents, health permits or veterinary inspections are not required for food imports of animal origin from *within the EU* in personal luggage, although the origin of the products must be clearly documented (FVO/BVET 2013e). However, some flights within Europe have known connections to third countries so that passengers from these flights are sometimes searched, and all meat and milk products arriving from outside the European Union are seized when found. In both airports, when a passenger is selected by a Customs agent for a search, typically all bags are searched and any meat or milk items found and coming from outside the EU are confiscated. In Geneva, the bags of passengers were typically x-rayed first, and based on x-ray results, some passengers were selected for a manual search. In Zürich, the volume of exiting passengers is higher, and some passenger's bags were x-rayed, while other passengers were chosen for a search without x-raying.

When making a confiscation, customs agents routinely weigh each confiscation in its entirety before disposal in a bio-safe container for later destruction as biological waste. In both Zürich and Geneva, all confiscations are recorded daily in a Microsoft Excel© database, including a brief description of the confiscated items. During a confiscation, Customs agents request information from passengers as to the type of meat or milk product. Confiscations recognized as wild meat by customs agents are typically given a generic 'bushmeat' description in their records (i.e. 'Buschfleisch' (*German*) or 'viande de brousse' (*French*)) or are described as some type of wild species (for example, 'Antilopenfleisch'/ antelope meat or 'Buschratten'/forest rats). If wild meats are not recognized, they are treated the same as all other meat products and are given a generic meat descriptor and disposed of upon confiscation. The total weight of the confiscation (in kilograms), the international country code, the flight number of the meat/passenger origin, and any actions in regard to the confiscation (i.e. fines and/or prosecution) is also recorded in the database. All of this information was made available for this study.

Bushmeat Metrics; Defining Measures

The measurement of bushmeat presents a number of difficulties. Bushmeat can arrive in many forms; as a whole carcass, a partial carcass, or as pieces, which can vary in size. Whole or partial carcasses are often recognizable as some type of wild (non-domestic) species by customs. However, in many cases, bushmeat is pieced for convenience, to better preserve it before travel, or to disguise it from customs agents. Therefore, each confiscation contained some number of items and/or some number of meat

products or distinct 'pieces', from which tissues samples were collected for DNA analysis. To avoid confusion between different aspects of sample collection and measurement in this study, the various bushmeat 'units' are defined as follows;

Confiscation - A *'confiscation'* describes all of the illegal meats removed from *one* passenger's luggage or from *one* cargo or mail shipment. Confiscations could contain multiple packages, containers, bags and/or pieces of meat or meat products in multiple forms. Confiscations were routinely weighed by airport customs agents to get a total weight of the confiscation to the nearest 0.1 kilograms.

Piece - Multiple items were often present within one confiscation; each of these was defined as a 'piece'. However, in some cases, *multiple 'pieces'* could be present within each item (i.e. packages, containers, etc. could contain multiple pieces of meat). Each distinct meat item in a given confiscation, be it a whole carcass, a single 'steak'/filet, or a small chunk of meat within a mixed stew, was defined as a 'piece'.

Sample – The term 'sample' refers to the tissue samples taken from pieces within a confiscation for DNA analysis. In most cases, tissue samples were collected from each individual 'piece' in a confiscation. Our DNA samples are therefore analogous to pieces in a confiscation. However, in the case of a large confiscation with multiple items or pieces, DNA extraction and analysis costs became prohibitive. In such cases, meat pieces were divided into morphologically similar groupings and samples were collected from 1 to 3 pieces in each grouping (depending on the total number of pieces present). While this could mean that large confiscations may be underrepresented in our study, we attempted to collect samples based on the proportional number of pieces present in a confiscation. As an example, our largest confiscation of bushmeat contained approximately 75-100 individual pieces, many of which were not morphologically identifiable - the largest number of samples was also collected from this confiscation (n=33).

Confiscation Scenarios in this Study

The collection of tissue samples for DNA analysis from meats confiscated at Zürich Flughafen and Genève Aéroport.was carried out under two different collection scenarios. These confiscation scenarios are as follows;

SCENARIO 1: Opportunistic Collection of Suspected Bushmeat in 2012

Tengwood Organization worked cooperatively with Customs from December of 2011 through January of 2013 to obtain tissue samples for DNA analysis, from which we identified wild species being smuggled into Switzerland. Customs agents at Zürich Flughafen and Genève Aéroport targeted confiscations of ***known or suspected bushmeat***. These confiscations were then sent to the Border Veterinarians of the Federal Veterinary Office (Grenztierarzt (GTU) / Bundesamt für Veterinärwesen (BVET)) where tissue samples, photos, and other information about the confiscation were collected. These tissue samples were then transported by Tengwood Organization to the University of Zürich's Institut für Rechtsmedizin, Forensische Genetik for DNA analysis. The Swiss Customs Administration (Eidgenössische Zollverwaltung/EZV) and the Customs Offices of Zürich Flughafen (Zollstelle Zürich-Flughafen) and Genève Aéroport (Inspection de douane Genève-Aéroport) provided supporting information about each confiscation from which tissue samples were collected from Customs records maintained at each airport. The majority of confiscations came from passenger luggage, but several came from opportunistically targeted cargo shipments and mail.

SCENARIO 2: Control Day Exercises in 2011-2012

In addition to our collection of samples from suspected bushmeat in 2012, scheduled exercises, known as 'Control Days' or 'Actions', took place at Flughafen Zürich and Genève Aéroport in 2011 and in 2012. These exercises are an infrequent, but cooperative effort carried out at each airport by Swiss Customs agents, Veterinary border staff (Grenztierarzt/GTU), Swiss Veterinary Authorities from the Federal Veterinary Office (FVO/BVET), and CITES, and with a goal of obtaining information on illegally smuggled animal and plant products. Tengwood Organization participated in 5 exercises which took place during the

period of September 2011 to December 2012; this included two control days at Flughafen Zürich (September 29th 2011 and December 20th 2012) and three control days at Genève Aéroport (October 13th 2011, December 23rd 2011, and October 4th 2012). Tissue samples were collected by Tengwood Organization from *all* meat items on these days in order to determine the proportion of the total confiscations which were identified as bushmeat. Confiscations on control days came only from passenger luggage, as cargo shipments and mail were not a part of these exercises.

Supplementary Data - Swiss Customs Records of All Meat and Milk Confiscations

Customs records of ***all meat and milk confiscations occurring during the period from 2008-2012*** at both Zürich Flughafen and Genève Aéroport were made available for this study by Swiss Customs Administration. Information from these records was analyzed to substantiate and support results from this study, including 1.) Determining the regional proportions of meat confiscations that were described/recognized by customs agents as bushmeat from 2008-2012, 2.) Determining the number and an average amount (in kg) for bushmeat confiscations in 2012 for use in a model created to quantify the amount of bushmeat smuggled annually, and 3.) Determining a rate of increase for confiscations recognized as bushmeat by customs agents from 2008-2012.

II. Objectives of the Study

The goal of this study was to characterize the illegal bushmeat trade into Switzerland by 1.) describing some of the characteristics of bushmeat arriving in Switzerland, 2.) identifying species at risk via DNA analysis of suspect meats, and 3.) quantifying the amount of bushmeat that is likely to be arriving in Switzerland from information on known confiscations.

1.) Characterizing the Illegal Bushmeat Arriving in Switzerland

We examined a number of characteristics which can aid Customs agents and other parties in finding bushmeat confiscations. A number of features of bushmeat were described, including 1.) The regions of origin and flight departure points for smugglers carrying bushmeat into Swiss airports, 2.) The physical characteristics that can be useful in distinguishing bushmeat or wild meats, and 3.) The average size of bushmeat confiscations.

Regions of Meat Origin and Flights Carrying Bushmeat into Switzerland

During a confiscation, Customs agents routinely collect information about what flight a passenger is arriving on and the country of origin of any meats confiscated. This information is entered into the customs confiscation records, allowing us to determine the regions/countries from which bushmeat originates, as well as those departure points and flights on which bushmeat is being illegally smuggled.

Identifying Unique Physical Characteristics of Bushmeat

We identified a number of categorical descriptors which can be used as predictor variables for bushmeat. Meat was first identified as either bushmeat or non-bushmeat (domestic, fish, or not identified). The following categorical descriptors were then used to describe bushmeat; 1.) The type of piece (whole carcass, partial carcass or piece), 2.) They presence or absence of certain physical features (i.e. head/ appendages, bones, skin/pelt, and mold/aging), 3.) The type of preparation (fresh/raw, smoked/dried, or cooked/spiced), and 4.) The type of packaging (commercial vs. non-commercial).

The Size of Bushmeat Confiscations

We used the data from this study, as well as the Customs Record data of all bushmeat confiscations over the past 5 years (2007-2012) to examine the size of bushmeat confiscations in comparison to all other types of meats confiscated.

2.) DNA analysis of suspect meats; Identifying Species at Risk from the Bushmeat trade

DNA testing was selected as the method of choice to identify species at risk from the bushmeat trade in Switzerland. Our study utilized an established forensic facility (Zurich Institute of Forensic Medicine, University of Zurich, Forensic Genetics) and standardized techniques in species identification (Morf et al 2013). The use of mitochondrial DNA methodologies for species identification allows for sound legal cases upon later prosecution of criminal offenders.

DNA Methodology

Samples typically consisted of a small piece of muscle tissue collected from each piece of bushmeat and placed in a secure container. After collection, tissue samples were transported to the Zurich Institute of Forensic Medicine, University of Zurich, Forensic Genetics, and stored at -20^{o}C. The methodology used to identify the species of origin of illegally smuggled meats imported into Switzerland consisted of a multiplex-PCR-setup with 8 primers varying in their specificity to amplify a region of the mitochondrial cytochrome b (*cytb*) gene in different animal classes (mammals, fishes, birds and cephalopods). This mtDNA based species identification method was first validated before its application to species identifications (Morf et al 2013). Sequences were then compared to reference sequences in an online gene database (http:/www.ncbi.nlm.nih.gov) to determine species identifications (Benson et al 2010). Details of the DNA methodology are not presented here, but are available in Morf et al (2013).

The results of the DNA identifications for samples in our study fell into one of the following categories; 1.) Positive species identification (showed a sequence homology of ≥98% to a reference sequence from the database), 2.) Identification to the genus level (sequences showed <98% of sequence homology to those in the database), 3.) No identification possible, due to no DNA or too little DNA, 4.) No identification possible, due to a mixture of DNA, and finally, 5.) No DNA analysis was attempted – species were visually identified to some level based on morphology.

Although DNA samples identified to the genus level (<98%) were considered ambiguous in the sense that the analysis did not identify the DNA sequence to the species level, for our purposes, the genus level result is still valid and also valuable for determining the broader categories of animals that are at risk. Those items identified visually were also included in our results, where appropriate. Photos were taken of all bushmeat confiscations and of all pieces from which samples were collected. For samples that were identified only to the genus level in DNA analysis, visual identification to the species level was sometimes possible with the aid of the supporting photographic and morphological evidence. For example, many of the pangolins identified only to the genus level (*Manis* spp.) in the DNA analyses came in as whole carcasses; photos of these were sent to the IUCN pangolin specialist group and used to identify them to the species level (see page 56).

Morphological Identifications

DNA analysis was attempted for 89% of the total samples (250 of 280 samples/data points in this study). In some cases (n=30 of 280, or 11% of the total samples), samples were not collected or not analyzed for one of the following reasons;

The item was visually identified as a fish species: Passengers arriving in Switzerland from countries outside the European Union may carry fresh, eviscerated fish or fishery products (fresh, dried, cooked, smoked, cured), including certain shellfish (prawns, lobsters, dead mussels, dead oysters) up to a maximum weight of 20 kg or the weight of a single fish that exceeds 20 kg for personal consumption (FVO/BVET 2013a). Therefore, DNA analysis was not attempted for fish found in confiscations in this study. However, our DNA analyses did identify 5 different fish species from sampled, unrecognizable meat pieces (9 samples from 4 confiscations were identified in the DNA analysis as 5 different fish species). Visual identifications of fish species included 2 confiscations of large amounts of shrimp accompanying other confiscated meats from Brazil and Nigeria (identified as likely to be 2 different species from the family *Penaeidae*, which includes the majority of species of commercially utilized shrimp).

The item was visually identified as an invertebrate species: Passengers arriving in Switzerland from countries outside the European Union with invertebrate species such as insects and molluscs/snails must have the proper import paperwork accompanying them. The TRAde Control and Expert System (TRACES) is a trans-European network for veterinary health which notifies, monitors and certifies imports, exports and trade in animals and animal products, including invertebrates (FVO/BVET 2013c, 2013d; EC 2009). Without the proper paperwork, invertebrate species known to be CITES-listed, or those that may pose a threat (such as introduced pest species) are routinely confiscated by Customs. DNA analysis were not attempted for any of the invertebrates found in confiscations in this study (5 confiscations of at least 4 different species). These included 3 confiscations in which Giant African Land Snails were present (*Achatina or Archachatina* spp.), and 2 confiscations containing 3 different insect species (suspected to be butterfly and honeybee larvae, but identified only to *Class Insecta*).

The item was visually identified as a non-meat animal product: We did not attempt analysis for confiscations that did not include meat; this included 1 confiscation of bird's nest soup from Thailand (a soup known to be made from the nest/saliva of the cave swift, genus *Aerodramus*), and 1 confiscation of crocodile skin phone covers from South Africa (identified as family *Crocodylidae*).

When visual identification was possible based on DNA analysis of identical specimens in a single confiscation: In the case of multiple *identical* whole carcasses in a single confiscation, a sample was collected from only one of the carcasses. There were 15 whole carcasses that were not sampled in our study because they were *morphologically identical* to other carcasses within the confiscation that *were* sampled for DNA analysis; 8 carcasses were identified to species level (*Atherurus africanus*), and 7 carcasses were identified to genus level (*Manis* spp.), based on corresponding DNA results for identical carcasses.

Determining an Overall Quantity for Species at Risk from the Bushmeat Trade in Switzerland

Whenever possible, pieces from which tissue samples were taken were individually weighed to the nearest 0.1 kilograms and these *piece weights* were recorded. However, it was not always possible to weigh all pieces due to time constraints (i.e. control days) and in cases where there were a large numbers of pieces in a confiscation. For certain species of interest, such as primates, pieces identified morphologically or from which a sample was collected, were weighed. Pieces were weighed for approximately 40% of our total samples (n=115 out of 280) and 44% of our bushmeat samples (n=78 out of 179).

In cases where confiscations contained too many pieces for all pieces to be weighed, the weights of pieces from which we extracted samples were estimated in order to determine an overall amount (in kg) for each at risk species in the study. Estimated piece weights were calculated by subtracting the weight of known pieces in a confiscation from the overall weight of the confiscation. The remaining kilograms in the confiscations were then divided equally between the pieces of unknown weight. In this way, weights for all pieces in a confiscation were either measured directly, or estimated based on the total kilograms present in the confiscation. This method of distributing the remaining weight of a confiscation equally between unknown pieces may over or underestimate the overall weight for some pieces/species. However, the majority of large pieces (i.e. whole and partial carcasses) were weighed, and the smaller chopped pieces in a given confiscation tended to be of a similar size.

The following formula describes our estimate for unknown piece weights:

$$Weight\ of\ unknown\ piece = \frac{total\ weight\ of\ confiscation\ -\ total\ weight\ of\ known\ pieces}{total\ number\ of\ pieces\ of unknown\ weight}$$

We then determined representation of species (i.e. a total weight for each species in this study) by taking the weight of each piece (in kg) identified as a given species, and summing these weights to determine a total weight (in kilograms) for each species found during the study.

3) Determining the Quantity of Bushmeat Arriving in Switzerland

We determined an estimate for the quantity of bushmeat arriving in Switzerland by creating a model which took into account the proportion of passengers searched from targeted flights on control days, the proportion of searched passengers that smuggled bushmeat, the average amount of bushmeat that smugglers carry into Switzerland, and the regions from which bushmeat is smuggled. Information in regard to how these parameters were determined and utilized is described below;

Targeted Flights

CITES 'control days' were exercises to look at one or more focal points of CITES-listed concern, such as ‘caviar’, ‘bushmeat’, ‘Chinese medicine’, ‘rare plants’, ‘corals’, etc. Depending upon the focus of a control day, airport customs personnel targeted flights for the control day beforehand by choosing those with connections to regions from which items of CITES interest originate; these flights were placed on a priority list, and an effort was made to search passengers from these flights. The control days in which we participated involved customs officers searching multiple passengers from a number of *targeted* flights (n=67). Once all targeted flights on the priority list were searched, additional fights of interest were chosen and searched. Information from targeted flights was used to determine search effort.

Search Effort; Proportion of Targeted Passengers Searched

Information on the total number of passengers on each targeted flight, the proportion of passengers searched, and the total number of meat confiscations for each control day was compiled. This information was used to determine the proportion of passengers carrying illegal meats of all types, and provided us with the means to estimate the proportion and quantity of confiscations that included bushmeat. In cases where information on the total number of passengers on a targeted plane was not known (n=14), the type of plane flown by that airline for that flight was obtained from a number of online references and flights were estimated to be at 70% capacity (in the Chaber study (2010), flights were estimated at 90% capacity, but an exploratory analysis of the flights in our study showed that only

12% of flights were at or above 90% capacity and that on average flights were at 62% capacity). All control day confiscations came only from passenger luggage, as cargo shipments and mail were not a part of these exercises.

Using the data outlined above, we determined search effort using the following formula:

$$Proportion\ of\ targeted\ passengers\ searched = \frac{Total\ number\ of\ passengers\ searched from\ control\ day\ targeted\ flights}{Total\ number\ of\ passengers\ on\ targeted\ flights}$$

The Total Number of Passengers Searched in Switzerland's Airports

The total number of passengers moving through the airport per hour was obtained from each airport's 2012 annual statistics (2012 Statistiksbericht, Flughafen Zürich, http://www.zurich-airport.com; Statistics of the Traffic Report 2012, Genève Aéroport, http://www.gva.ch). Based on a 365 day calendar year and a 24 hour day, we used the total annual volumes to estimate the proportion of the total arriving passengers searched by using the following formula:

$$Proportion\ of\ overall\ passengers\ searched = \frac{Estimated\ number\ of\ passengers\ arriving\ at\ airport\ during\ control\ day\ search\ hours}{Total\ number\ of\ passengers\ searched\ from\ targeted\ flights}$$

Proportion of Passengers Smuggling Bushmeat

Tissue samples for DNA analysis were collected from *all* meat items on control days in order to determine the proportion of total meats that was bushmeat. Using the total number of meat confiscations and kilograms vs. the total number of bushmeat confiscations and kilograms from our control days, we estimated the proportion of smuggled meats that were identified as bushmeat in our DNA or morphological analyses. All information in our sample database was collated with the Customs records collected on confiscations, which included information on flight number, country origin, and information from the passenger in regard to meat origin and other details.

Average Size of Bushmeat Confiscations

Using the data from all bushmeat confiscations collected during this study, combined with any additional bushmeat or wild meat confiscations found in the Customs database records for 2012, we estimated an average weight (in kg) for confiscations containing bushmeat.

Determining How Much Bushmeat Arrives in Switzerland; Estimating Smugglers and Amounts

After identifying those regions which smuggle bushmeat into Switzerland, a model was created, which used the search parameters from our control days and airport data on total passenger volumes (modified/weighted by the proportion of bushmeat from each smuggling region) to estimate an overall number of smugglers for each region. This number of smugglers for each smuggling region was then multiplied by the average amount of bushmeat smuggled to estimate a total amount of bushmeat for each smuggling region. Summing these amounts allowed us to estimate the total amount of bushmeat that was likely to have arrived in Switzerland in 2012. More details of the methodology are presented with the model.

RESULTS:
Overview of Bushmeat in Swiss Airports

RESULTS:

I. Overall Bushmeat Confiscations in this Study

A total of N=280 tissue samples from 58 confiscations, weighing a total of 296.16 kg, were collected during the course of this study. The majority of confiscations occurred in 2012, although sampling started in September of 2011 and continued through the end of January 2013. Our DNA results showed that 27 of the 58 confiscations smuggled into Switzerland during the study period, weighing a total of 225.45 kg, contained bushmeat. Some bushmeat confiscations included small amounts of domestic meats or fish, mixed in with wild species, but 91% of the total kilograms in these confiscations were identified as wild species (204.17 of 225.5 total kilograms). Results from tissue samples collected from these confiscations showed that 64% of samples (n=179 of 280 samples) were some type of bushmeat or wild meat. The remaining 36% (n=101) of the samples were identified as follows; 1.) meat from a domestic species (n=68 of 280 samples, 24%), 2.) meat from a fish species (n=9 of 280 samples, 3%), or 3.) an unidentified meat sample for which DNA results were inconclusive (n=24 of 280 samples, 9%; these were meats for which species was not able to be identified, either visually or in our DNA analysis). Results are summarized in **TABLE 1** and **TABLE 2**.

Confiscations occurred under two different scenarios; either during scheduled control day exercises or via opportunistic collection of suspected bushmeat by customs agents. Because the opportunistic samples were collected by customs agents from meats that were *already suspected* of being bushmeat, the proportion of samples that would be identified as bushmeat was likewise expected to be high; for this reason, we examined the *opportunistic collection of suspect bushmeat* and our *control day confiscations* of all meats separately for some analyses. To determine the proportion of overall meat confiscations that were bushmeat, we used only control day data, where all meat confiscations were sampled. In the case of identifying species at risk from the bushmeat trade, we used all samples, from both opportunistic bushmeat collection and those bushmeat confiscations occurring on control days.

1.) Opportunistic Collection of Suspected Bushmeat in 2012

Determining Species at Risk from the Bushmeat Trade in Switzerland

During opportunistic collection of samples in 2012, a total of N=25 confiscations were recognized or suspected by Customs agents of being bushmeat, and N=186 tissue samples were collected from these confiscations. The results show that customs agents were largely correct in their identification of confiscations as containing bushmeat; 84% of the **confiscations** they selected (n=21 out of 25, weighing a total of 206.65 kilograms or 95% of the total kilograms) contained bushmeat, while only 16% (n=4 confiscations, 10.72 kilograms) contained no bushmeat. Several bushmeat confiscations included a very small amount (<1%) of domestic or fish species, but after species identification of samples, the majority (204.17 of the 206.65 kg) were identified as wild meat. Results are summarized in **TABLE 3**. Results for the **samples** collected from opportunistic confiscations were similar; 84% of the total samples collected (n=157, 188.4 kg) were identified as a wild species. The remainder of the samples (16%) were identified as either a domestic species (n=21, 22.87 kg), a fish species (n=6, 4.95 kg), or were not identified (n=2 and 1.2 kg). Results are summarized in **TABLE 4**. Meats identified as wild species on control days were also included in our analyses for determining species at risk from the bushmeat trade in Switzerland, but are discussed in detail in the next section.

Opportunistic confiscations of suspected bushmeat were collected from 3 different sources: 1) **passenger luggage**, 2) **cargo shipments**, and 3) **mail**. The majority of opportunistic samples (n=146)

came from passenger confiscations carried in personal luggage (n=18), and contained 79% of the total kilograms (172.56 of 217.37 kg). Of those opportunistic samples collected from passenger luggage, 88% were identified as some type of bushmeat. Customs agents also collected suspected bushmeat confiscations from 6 cargo shipments (n=37 samples), representing 19% of the total kilograms in this study (41.99 kg); 80% of the kilograms in these cargo confiscations were identified as some type of bushmeat. One cargo confiscation contained bushmeat that was pieced, bagged and hidden inside a sack of peanuts within a larger consignment of food from Cameroon for Swiss markets (SDA 2011), demonstrating that bushmeat smugglers are aware the meat is not allowed and are using methods to escape detection. One confiscation of suspected bushmeat arrived in a mail shipment from Nigeria (n=3 samples), containing 1% of the total kilograms (2.82 kg) and identified as domestic donkey (*Equus asinus*) and an unidentified meat.

Of note, our opportunistic sampling did not include every confiscation of bushmeat that is recorded in the 2012 Custom's records for Zürich Flughafen and Genève Aéroport. In Zürich, bushmeat confiscations sampled for this study represent only 44.4% of the total confiscations that customs agents described in their 2012 records as bushmeat or some type of wild meat (we collected samples from 79% of confiscations carrying a generic 'bushmeat label in the records, and from 8% of those labeled by customs as some type of wild species). Sample collection was more intensive at Zürich Flughafen than at Genève Aéroport; only 15% of the total bushmeat and wild meat confiscations recorded in the 2012 Genève Aéroport customs confiscation database were sampled for the study (20% of those labeled as 'bushmeat', and 7% of those labeled as some type of wild species were sampled for the study).

2.) CITES/BVET Control Day Exercises

Determining the Proportion of Meat *vs.* Bushmeat coming into Switzerland

Control day confiscations were taken from passenger luggage during searches that occurred on planned control day exercises to monitor the illegal smuggling of wild fauna and flora. During **control days**, we collected 94 total samples from 33 confiscations weighing a total of 78.79 kilograms. The majority (73%) of the control day confiscations came from 2 control days at Zürich Flughafen (n=24), with the remaining 27% from 3 control days at Genève Aéroport (n=9). These results reflect differences in the total volume of air traffic moving through these two airports and consequently, the number of confiscations occurring on a daily basis; Zürich Flughafen total passenger volumes are roughly double that of Geneva. The total number of meat confiscations coming into Zürich vs. Genève is likewise higher per year; in 2012 there were a total of 4183 confiscations containing 5871.72 kg of meat confiscated at Zürich Flughafen, and 408 confiscations containing 1257.98 kg of meat at Genève Aéroport (Swiss Customs/Eidgenössische Zollverwaltung *unpublished record data*).

Control day confiscations were taken only from passengers, during searches of their personal luggage. All meats confiscated on control days were sampled for two reasons; 1.) to determine the proportion of confiscated meats that were bushmeat, and 2.) to identify species at risk. As expected, the majority of control day confiscations (82%) contained no bushmeat - only domestic meats, fish, and/or unidentified meat products (n=27), and representing 76% of the total kilograms collected on control days (59.99 kg). However, it is interesting that some type of bushmeat or wild meat was identified on every control day; 18% of control day confiscations (n=6) contained some type of wild meat product and DNA results from samples taken from these confiscations showed that 20% of the total kilograms of meat collected on control days (15.82 kg) were definitively identified as originating from a wild species. Results for both opportunistic collection of bushmeat in 2012 and the control day meat collection are summarized in **TABLE 3** and **TABLE 4**.

TABLE 1: The total number of confiscations and their weight in kilograms for all confiscations in this study, and the total number of samples collected from these confiscations.

Type of Confiscation	Total number of confiscations	Total number of samples collected from confiscations	Total weight of confiscations in Kilograms
Confiscation contained bushmeat	27	204	225.45
No bushmeat was present in confiscation	31	76	70.71
Grand Total	**58**	**280**	**296.16**

TABLE 2: Results after identification of samples into meat types; the total number of samples and their weight in kilograms for each meat type (Note that some confiscations containing bushmeat also contained a small amount of other types of meats; of the 225.45 kg in confiscations that contained bushmeat, 204.17 kg were identified as wild meats and 21.28 kg were fish or domestic meats).

Meat sample identified as…	TOTAL NUMBER OF SAMPLES	TOTAL KILOGRAMS
Bushmeat	179	204.17
Domestic	68	68.32
Fish	9	5.89
Unidentified meat	24	17.79
Grand Total	**280**	**296.16**

TABLE 3: The number of confiscations, samples, and total kilograms for all confiscations containing bushmeat and those without bushmeat present, collected under the two different confiscation scenarios.

Types of Meat in Confiscation	2012 Opportunistic Collection of Suspected Bushmeat			Control Day Collection		
	Number of Confiscations	Number of samples	Total Kilograms	Number of Confiscations	Number of samples	Total Kilograms
Confiscation contained bushmeat	21	177	206.65	6	27	18.80
Confiscation contained only domestic, fish, and/or unidentified species	4	9	10.72	27	67	59.99
Grand Total	**25**	**186**	**217.37**	**33**	**94**	**78.79**

TABLE 4: The total number of samples and weight in kilograms for the types of meats identified in this study, collected under the two different confiscation scenarios.

Meat sample identified as…	2012 Opportunistic Collection of Suspected Bushmeat		Control Day Collection	
	Number of samples	Total Kilograms	Number of samples	Total Kilograms
Bushmeat	157	188.35	22	15.82
Domestic	21	22.87	47	45.44
Fish	6	4.95	3	0.94
Unidentified meat	2	1.20	22	16.59
Grand Total	**186**	**217.37**	**94**	**78.79**

RESULTS:

Regions from which Bushmeat Arrives in Switzerland

II. Smuggling Regions; Bushmeat Arrival into Switzerland

Confiscations of meats were collected from flights originating in 24 countries during the study, and bushmeat was confiscated from 10 of these countries. Of the 14 countries which smuggled no bushmeat, the majority of these were confiscations occurring during control day exercises, where passengers arrived with some type of meat that was determined to be from a domestic species, a fish species, or a species which was not identified in the analyses (most often a commercially processed meat, see page 54).

Bushmeat Smuggling – Africa as a Region of Concern for Switzerland

Our results show that passengers arriving from ***African*** countries carried the majority of bushmeat into Switzerland; 98.5% of the total kilograms of bushmeat (201.1 of the 204.2 total kg of bushmeat) came from African countries, with the region of ***West/Central Africa*** accounting for 91% of the total bushmeat kilograms found during this study (183.9 of 204.2 kg), marking this as a region of significant concern in regard to bushmeat imports. Even more surprisingly, ***one*** West/Central African country was responsible for importing the majority of this meat in this study; this country is ***Cameroon***. Passengers or cargo arriving from the country of Cameroon were responsible for a substantial 79% of the total kilograms of bushmeat identified in this study. Other West/Central African countries that smuggled amounts of bushmeat into Switzerland during this study included the Ivory Coast (4%), Nigeria (3%), the Democratic Republic of Congo (2%), Togo (1%), and one unknown West/Central African country (2%).

Kenya was the only East African country in our study from which bushmeat originated. The country of Kenya smuggled the second highest amount of bushmeat kilograms after Cameroon; however, this was one passenger who arrived in Switzerland carrying the second highest amount of bushmeat of any passenger in this study (7% of the total bushmeat kilograms, or 13.8 of 204.2 kg). It must also be noted that this passenger traveled to Zürich via a connecting flight originating in Cameroon, making it possible that the meat was purchased there. The country of South Africa carried only 0.5% of the total kilograms (1.0 of 204.2 kg) during this study. Other regions smuggling wild meats during the study included the Far East and the Middle East, but together, these were responsible for a very small proportion of the total kilograms of bushmeat or wild meat (3kg or 1.5% of the total kilograms). Overall, African countries carried 98.5% of the bushmeat into Switzerland during our study. Results are presented in **TABLE 5** and **FIGURE 1**.

Customs Records of Meat Confiscations from Africa

The result that Africa, and especially the West/Central African region, is of concern regarding bushmeat imports is also supported by an examination of Customs records. We looked at *all meat confiscations* occurring in 2012 and found that the proportion of the total meat confiscations *described by Customs agents as bushmeat or wild meat* was higher for Africa than for all other regions from which meats were smuggled; 17% of the meat confiscations arriving in Zürich from Africa, and 14% of those arriving in Geneva from Africa, were identified by customs agents as bushmeat or wild meat. The proportion of the total kilograms of meat from Africa that these confiscations represent was even higher; in Zürich, 40% of the total kilograms arriving from Africa were described as bushmeat or wild meat, and close to 20% of the total kilograms arriving in Geneva from Africa; this result is explained by another important finding of this study; bushmeat confiscations tend to be larger than all other types of meat confiscations (see our results on pages 47-51). The proportion of total confiscations and kilograms that were recognized as bushmeat or wild meat in the Customs records was ≤10% for all other regions. Passengers from Africa were more likely than passengers from any other region to be carrying bushmeat confiscations, and

these confiscations tended to be heavier than other type of meat confiscations. These results are demonstrated in **FIGURE 2a and 2b**.

We also examined *confiscations described as bushmeat or wild meat* by Customs Agents in the Customs Records for the past 5 years (the period of 2008-2012) for Zurich and Geneva considered together. During this period, African countries smuggled 91% of the total kilograms described in the records as bushmeat or wild meat, with West and Central African countries smuggling the majority of this (81% of the total bushmeat/wild meat kilograms). Again, the country of Cameroon smuggled the highest amount; Cameroon was alone responsible for 58% of the total confiscated kilograms described as bushmeat or wild meats during this period. These results can be viewed in the maps presented in **FIGURE 3 (Map 1 and 2)**.

Airlines Carrying Bushmeat into Switzerland

A number of different airlines were found to carry bushmeat into Switzerland during the study; the majority of the total weight (in kg) of bushmeat arrived on passenger flights from SWISS (41%), Brussels Airlines (21%), and Air France (16%); together, 78% of the total kilograms of bushmeat came into Switzerland on these 3 airlines. Cargo flights from known and unknown carriers also brought a substantial amount of bushmeat into Switzerland; 17% of the total bushmeat kilograms came in on cargo flights from Africa. Considered together, these three passenger airlines (SWISS, Brussels Airlines, and Air France), together with cargo flights, carried 95% of the total kilograms of bushmeat into Switzerland. Results can be viewed in **TABLE 6** and **FIGURE 4**.

Departure Point of Bushmeat; Origin of Flights Carrying Bushmeat into Switzerland

While information about the region of origin of smuggled bushmeat and the airlines that carry it into Switzerland can be useful in predicting flights or airlines which may carry bushmeat, it is not the whole picture for the bushmeat arriving here; the ***departure point*** of flights carrying bushmeat into Switzerland also tells us something about how bushmeat travels. Chaber's study in Paris looked only at bushmeat that arrived at the Charles De Gaulle airport on ***direct Air France flights from Africa***; however, Switzerland has very few direct flights from Africa; during the study period, these included 1 direct flight from South Africa (*LX 289, departing from Johannesburg*), 1 from East Africa (*LX 293 departing from Dar Es Salaam via Nairobi*) and 1 from Central Africa (*LX 275, departing from Douala, Cameroon to Zürich*) – this latter flight from Cameroon (LX 275) was discontinued during the study, but during the period it was still running (through March of 2012), it was responsible for 19% of the total bushmeat kilograms carried into Switzerland during this study, direct from Cameroon. Interestingly, after the discontinuation of the direct flight from Cameroon to Zürich, the flight most often found to be carrying bushmeat into Switzerland was a codeshare flight of SWISS and Brussels Airlines (*the LX 771/SN 5101, departing from Brussels, Belgium to Zürich*). This flight was also responsible for 19% of the total bushmeat kilograms carried into Switzerland during the study, all of which came originally, but indirectly, from Cameroon.

While it is clear that most bushmeat *originates* in West and Central African countries, the majority of the bushmeat actually arrived in Switzerland on flights with ***departure points inside Europe****; i*n fact, these flights were found to be carrying the majority (60%) of the bushmeat kilograms into Switzerland. Most of the flights that landed with bushmeat in Zürich or Geneva and came from either Brussels Airport in Belgium (43%) or from the Charles De Gaulle Airport in Paris, France (16%). The fact that the departure point of most flights carrying bushmeat into Switzerland is *inside Europe* can complicate the search for bushmeat and is one of the most important findings of this study. Because there are very few direct flights from Africa to Switzerland, most bushmeat arrives in Switzerland *cryptically*, on *flights from within the EU*. A comparison of meat origin vs. flight origin can be viewed in **FIGURE 5**.

TABLE 5: Regions and countries of illegal bushmeat imports into Switzerland: Results for the number of confiscations, the number of samples, and the proportion of the total kilograms from each region smuggling bushmeat into Switzerland during the study.

REGION	Number of confiscations	Number of samples	Regional Proportion of Kilograms	Proportion of bushmeat kilograms by Country
AFRICA	***25***	***177***	***98.5%***	
West/Central Africa	23	145	91.3%	Cameroon (79.2%) Ivory Coast (3.6%) Nigeria (3.2%) Democratic Republic of Congo (2.3%) Togo (1.2%) Unknown West/Central African (1.8%)
East Africa	1	31	6.8%	Kenya (6.8%)
South Africa	1	1	0.5%	South Africa (0.5%)
ALL OTHER REGIONS	***2***	***2***	***1.5%***	
Middle East	1	1	1.2%	Israel (1.2%)
South East Asia	1	1	0.3%	Singapore (0.3%)

FIGURE 1: Countries from which bushmeat was smuggled into Switzerland during this study; the proportion of the total kilograms of bushmeat carried into Switzerland during the study for each country is indicated on the chart. Numbers next to each country in the legend are the kilograms of bushmeat smuggled by each country.

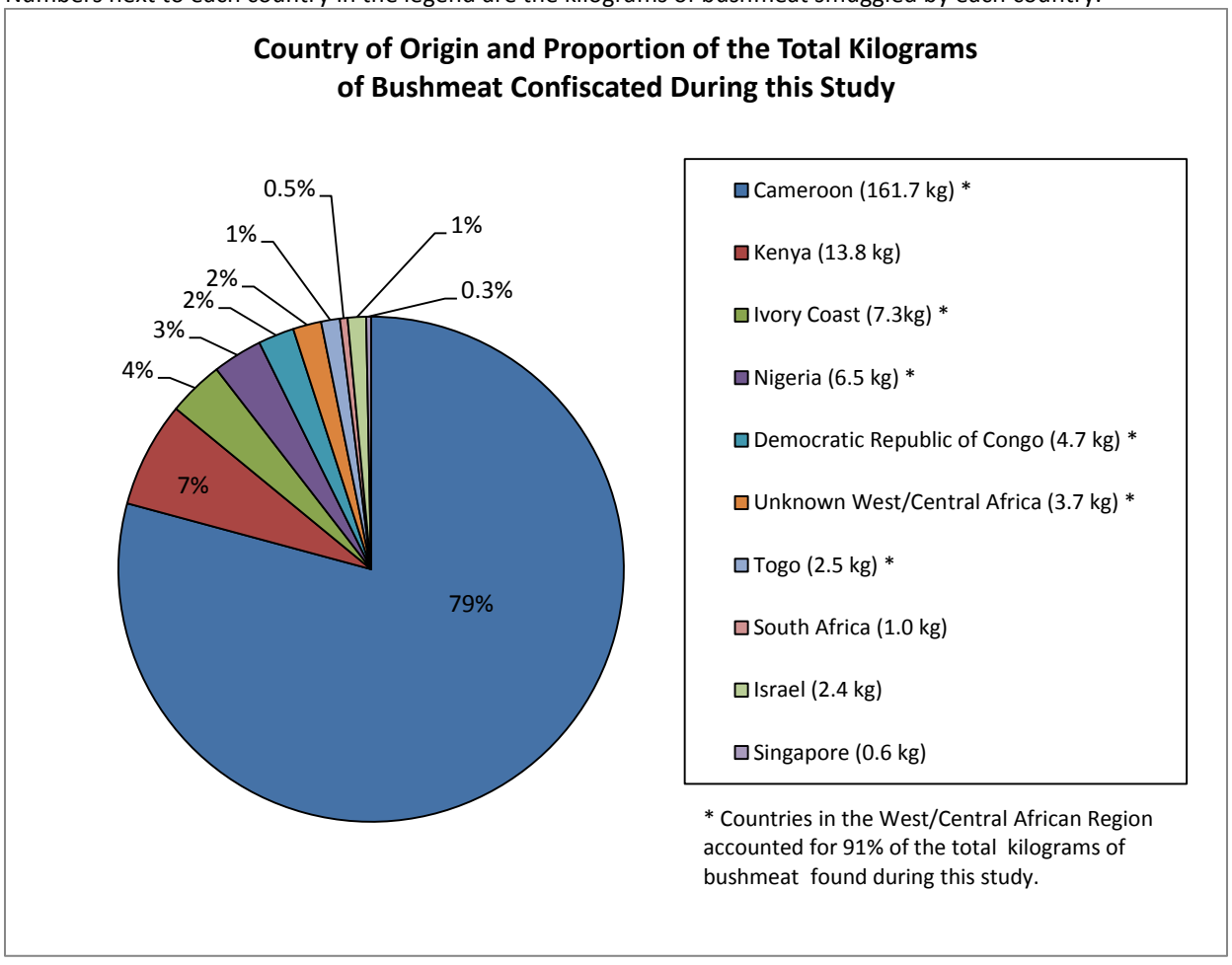
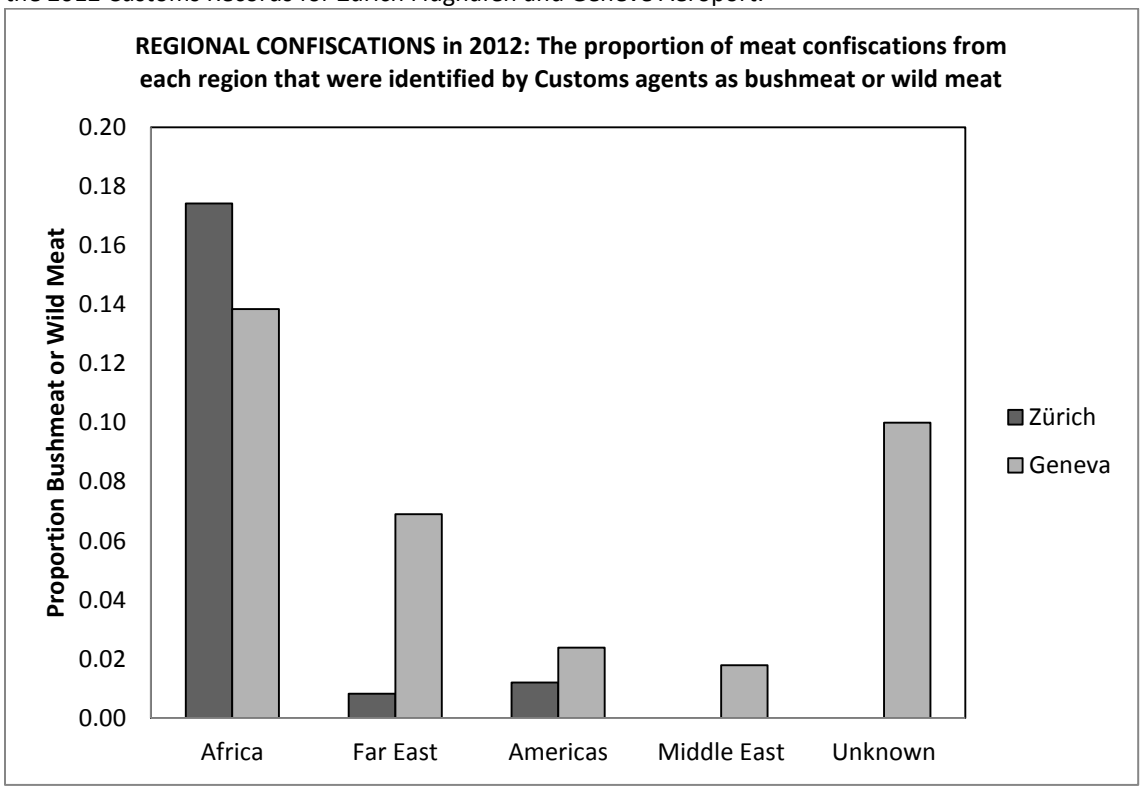
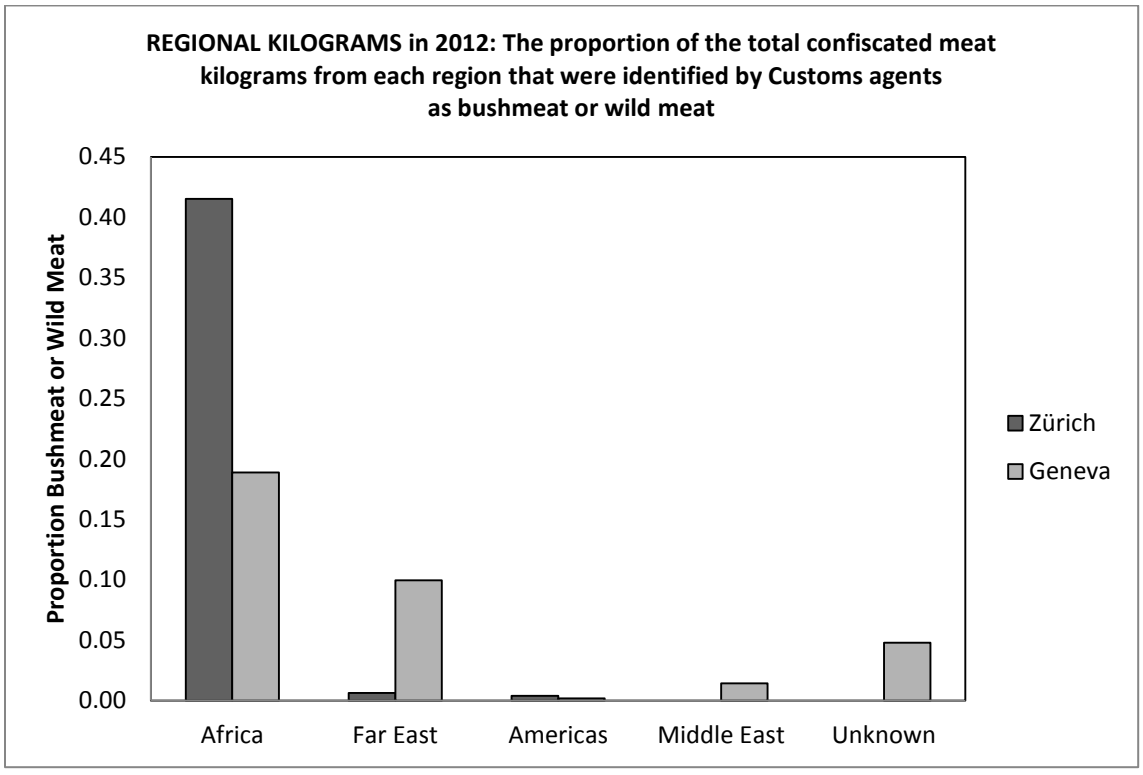


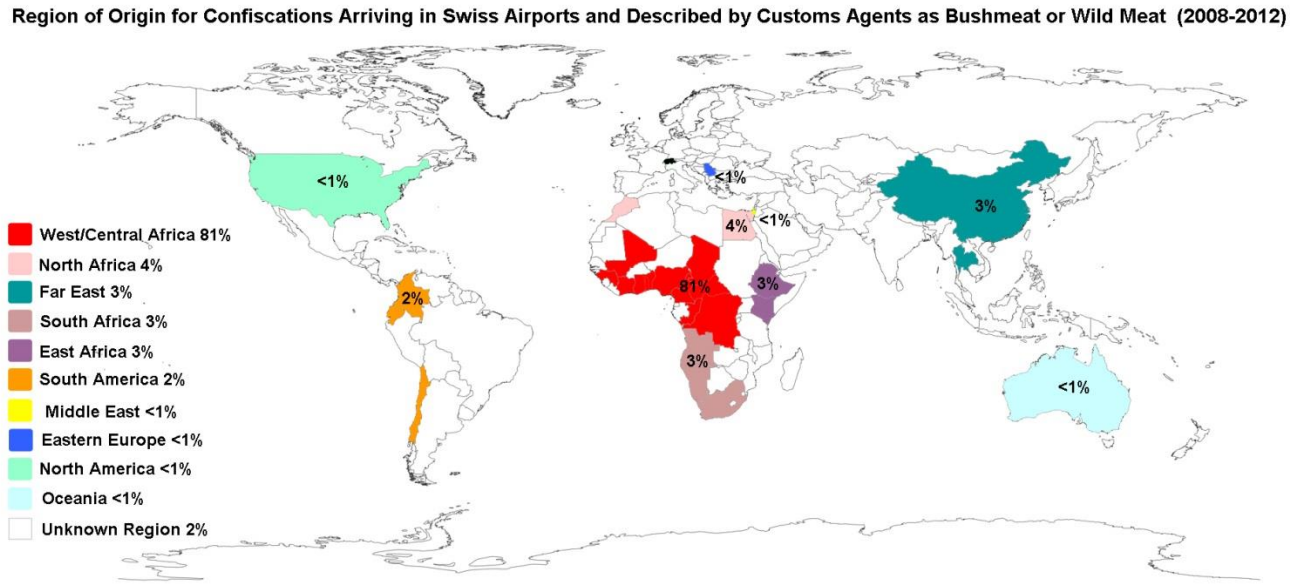
FIGURE 2 a and b: Regional Confiscations and Kilograms of Bushmeat in 2012; For each region, the proportion of the total meat confiscations that were described by Customs agents as bushmeat or as some type of wild meat in the 2012 Customs Records for Zürich Flughafen and Genève Aéroport.





*Bushmeat confiscations are larger than all other types of meat confiscations – see results on pages 47-51.

FIGURE 3: Region of Origin of Confiscated Meat Kilograms Described by Customs Agents as Bushmeat or Wild Meat in the Customs Records for 2008-2012; **MAP 1:** World map of the proportion of the total confiscated kilograms that were described by Customs agents as bushmeat or wild meat in the 2008-2012 Customs Records for Zurich and Geneva Airports combined, and **MAP 2:** For African countries only; the proportion of the total meat kilograms described as bushmeat or wild meat from each African country for the period of 2008-2012 (Note that Africa smuggled 91% of the total bushmeat kilograms during this period).



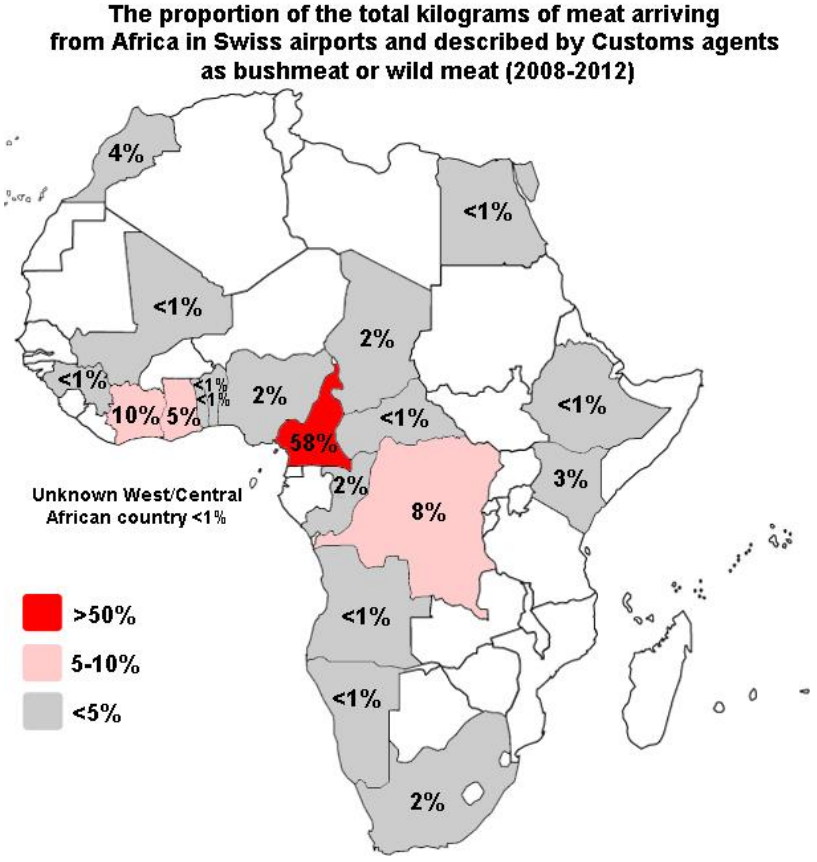


TABLE 6: Airlines and Bushmeat: The number and proportion of confiscations containing bushmeat and the total kilograms of bushmeat carried for all airlines and flights that carried bushmeat into Switzerland during the study.

Airline	Number of confiscations	proportion of confiscations	Total kilograms of bushmeat	proportion of kilograms	Flight ID, Total Kilograms, and Number of Samples of Bushmeat in Confiscations	
PASSENGER FLIGHTS						
Swiss	7	0.26	83.7	0.41	LX 771* LX 275 LX 787*	(39.0 kg, n=27) (37.9 kg, n=8) (6.8 kg, n=2)
Brussels Airlines	7	0.26	42.8	0.21	SN 2711 SN 372 SN 5101* SN 2713	(16.8 kg, n=26) (13.8 kg, n=31) (11.2 kg, n-11) (1.0 kg, n=3)
Air France	3	0.11	32.9	0.16	AF 1614 AF 1642 AF 5100	(22.8 kg, n=9) (8.3 kg, n=17) (1.8 kg, n=1)
Royal Air Maroc	1	0.04	6.3	0.03	AT 930	(6.3 kg, n=11)
Easy Jet Switzerland	1	0.04	2.4	0.01	EZS 1526	(2.4 kg, n=1)
Lufthansa	1	0.04	1.7	0.01	LH 1184	(1.7 kg, n=3)
Singapore Airlines	1	0.04	0.6	0.003	SQ 346	(0.6 kg, n=1)
CARGO FLIGHTS						
Unknown Cargo Flights	4	0.15	27.7	0.14	4 Cargo Flights (unknown airline)	(27.7 kg, n=22)
Turkish Airlines (cargo flight)	1	0.04	3.0	0.01	TK 6324 (via Strategic Air Cargo Nigeria)	(3.0 kg, n=4)
Aero Lines GMB (Zürich cargo flight)	1	0.04	3.1	0.02	AERO Lines GMB Zürich	(3.1 kg, n=2)
TOTAL FLIGHTS	***27***	***1.00***	***204.2***	***1.00***		

* The LX 771 and SN5101 and the LX787 and SN5103 are codeshare flights of SWISS and Brussels Airlines.

FIGURE 4: Bushmeat kilograms by Airline; Airlines which carried bushmeat confiscations into Switzerland in 2012.

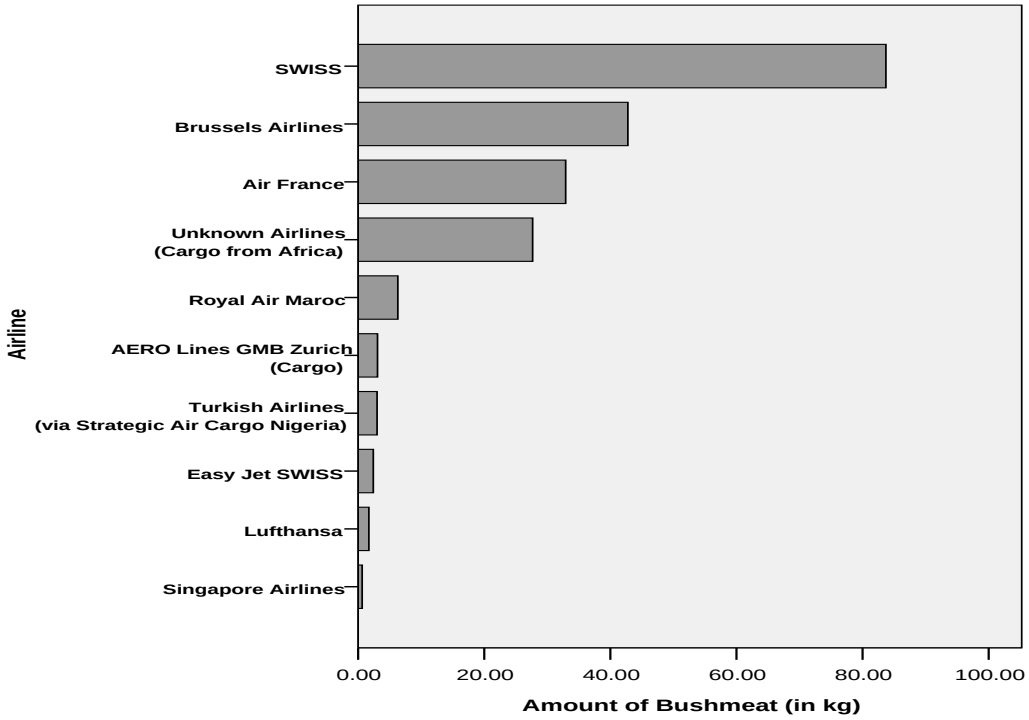
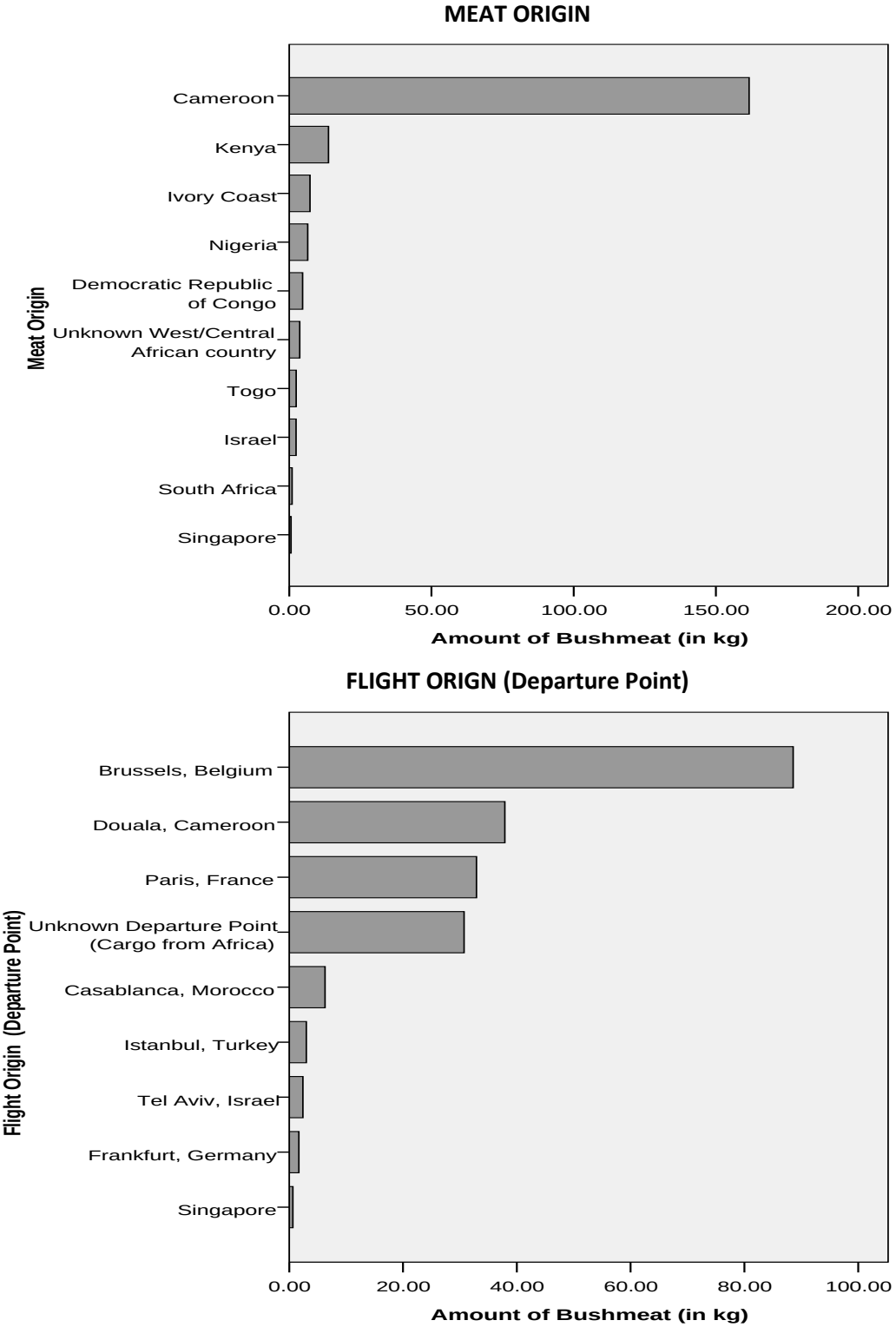


FIGURE 5: ***Meat Origin vs. Flight Origin***; A comparison of the meat origin and flight origin (i.e. departure point) for all bushmeat arriving in Switzerland during this study; While the majority of kilograms identified as bushmeat in this study came from West and Central African countries, most of this bushmeat arrived in Switzerland on ***transit flights from within Europe*** (with the majority carried on flights arriving from Brussels, Belgium).



RESULTS:
Identifying Characteristics of Bushmeat

III. Identifying Characteristics of Bushmeat

One of the main problems for Customs agents is that meats arriving in the airports are often processed in some way that makes them unrecognizable to the species level. This study showed that a number of characteristics are typical of bushmeat arriving in Swiss airports and that furthermore these characteristics can be used by customs agents to help identify these meats. Identification of meat at the time of confiscation allows for collection of additional information and more effective subsequent prosecution of offenders. The identifying characteristics of bushmeat described in this section are illustrated in **FIGURE 6** through **FIGURE 16**.

Bushmeat Preparation, Preservation, Presentation and Packaging for Switzerland

In Africa, bushmeat is often found as whole, fresh carcasses, but once animals must be carried some distance, the carcass is often cut into more manageable pieces; carcasses may be pieced by hunters in the forest for ease of transport, by sellers in African markets to better preserve the meat for longer periods, or in the case of bushmeat smuggling, to disguise it from customs agents. Although bushmeat can and did arrive in Swiss airports as fresh/raw whole carcasses, much of it arrived in pieces. Some type of preservation typically occurs before bushmeat begins to travel, such as smoking, drying, or cooking (Heinz and Hautzinger 2007). Preservation techniques in Africa are limited, and smoking or drying meats are the two most common types of preservation; in West/Central Africa, smoking meat is the preferred method. In the smoking process, organs are first removed and the carcass is cut down the middle and stretched on a rack with arms and legs pinned to support carcass weight (Peterson and Ammann 2004). Smoking techniques place the animal over a wood fire for some time period; short periods over a hot fire will burn off the hair/pelt while the meat inside remains fresh. A blowtorch is sometimes used to remove hair instead and washing carcasses after the smoking process can also remove hair. With longer periods over a fire the meat becomes partially or fully cooked and/or dried. Fully dried meats can be reconstituted in water before consumption. Smoking techniques use wood, wood that has been mixed with oil, or even other materials such as plastics, refuse, or old tires in place of wood. Environmental contaminants such as polycyclic aromatic hydrocarbons (PAHs) are associated with the smoking process and unsanitary conditions during preservation and travel can result in microbiological contamination of the meat (Glawogger 2006; Akpambang et al 2009; Chaber 2009; Abdul et al 2013; Sartore 2013).

Bushmeat arrived in Swiss Airports as *whole carcasses*, as *partial carcasses*, and as *pieces* (which varied in size). Whole carcasses were often recognizable as a wild (or non-domestic) animal, although not always recognizable to species because of hair removal and features being obscured during the smoking process; whole carcasses represented 21% of the total bushmeat samples (n= 38, 86.4 kilograms) and partial carcasses were 8% of the total bushmeat samples (n=14, 17.4 kilograms). In contrast to wild species, the smuggling of whole or partial carcasses is rare for domestic species; only 1 incidence of a whole domestic pig carcass from Togo was recorded during the study. By far, however, the majority of bushmeat coming into Switzerland was pieced; 71% of the bushmeat samples came from bushmeat arriving in the airport already pieced and therefore more difficult to visually identify to species. But because whole and partial carcasses tend to weigh more than pieces, approximately half (51%) of the total kilograms of bushmeat collected from confiscations were whole or partial carcasses, with the remainder being pieced bushmeat. These results can be seen in **TABLE 7** and in the photos in **FIGURE 7** through **FIGURE 9**.

In regard to the types of preparation for bushmeat arriving in Swiss airports, most bushmeat in this study arrived as either fresh (i.e. raw) meat (52%) or as smoked meats (45%). The remainder was cooked and/or spiced meats. These results are presented in **TABLE 8** and in the photos in **FIGURE 6**. When

considering presentation (i.e. whether bushmeat was pieced or whole/partial carcasses) and preparation type (fresh/raw, smoked, or cooked/spiced) together, whole and partial carcasses most often came fresh (48%) or smoked (44%), while pieces were more likely to be smoked (65%) than fresh (31%). Close to half of the sampled bushmeat in the study (47%) arrived as *smoked pieces*, and a substantial portion of the remainder (35%) was from *fresh* bushmeat carcasses or pieces. The combination of presentation and preparation is presented in **TABLE 9**.

In regard to packaging, bushmeat was most often found 'bagged'; typical packaging included wrapping bushmeat items in brown paper, newspaper, other types of paper, or in aluminum foil, and placing this wrapped bushmeat in non-descript plastic bags. Plastic bagging items was the most common way to smuggle bushmeat; 97% of our 2012 collections of suspected bushmeat were non-commercially bagged in plastic, with the remainder in other types of wrapping or in non-commercial, plastic containers. Types of packaging for bushmeat can be viewed in the photos in **FIGURE 16**. Commercially packaged meat items (i.e. meats that have undergone commercial processing and had adequate company information on the packaging) were found only on control days; of the total 94 control day samples, 33% (31 of 94) were commercially packaged and *only 1 of these commercially packaged items was found to be wild meat*; a can labeled as chicken luncheon meat from China, but identified in the DNA analysis as mallard duck (*Anas platyrhynchos*).

Obviously, whole carcasses are the most easy to recognize as wild or non-domesticated animals. In this study, we also identified characteristic features of ***pieces*** that can be indicative of bushmeat. As obvious examples, 1.) intact and recognizable ***heads***, and/or 2.) ***appendages*** (arms/legs, and paws/hands/feet/ hooves) may still be attached to pieces. Other recognizable characteristics of pieced bushmeat includes; 3.) visible ***bones*** in pieces, especially the long bones of the arms/legs, and bones of the ribcage and/or vertebrae, 4.) the ***pelt/hair*** or ***hide/skin*** is often still present on pieces as this is thought to add flavor to soups or stews (especially for antelope and other hooved stock), and finally, 5.) a characteristic ***foul odor*** and/or ***discoloration*** and/or ***mold*** is sometimes visible on the meat (Pavel 2012). This is due to the limitations in preservation techniques available in tropical Africa and the time it takes for the bushmeat to travel from the African forest to Switzerland. The photos in **FIGURE 10** through **FIGURE 15** illustrate some of these identifying characteristics.

In response to this study, a bushmeat identification booklet featuring some of the identifying characteristics of bushmeat was created by Tengwood Organization and BLV (BLV and Tengwood Organization 2014[3]). It is hoped that this guide will be useful to Customs and other agencies responsible for bushmeat identification in ports of entry.

[3]A brochure was created by Tengwood Organization and the Federal Food Safety and Veterinary Office (Bundesamt für Lebensmittelsicherheit und Veterinärwesen **/** BLV) in order to provide Customs Agents, Veterinary Authorities, and other agencies responsible for identification of bushmeat, with some of the typical characteristics of bushmeat arriving in developed world ports of entry. This brochure is available in German, English, French and Italian on the Federal Food Safety and Veterinary Office website at www.blv.org and on the Tengwood Organization website at www.tengwood.org.

TABLE 7: The type of presentation for all bushmeat samples and kilograms arriving in Swiss airports during this study.

Type of Presentation	Number of Samples	Weight (in kilograms)	Proportion of samples	Proportion of kilograms
Pieces	127	100.4	0.71	0.49
Whole carcasses	38	86.4	0.21	0.42
Partial Carcasses	14	17.4	0.08	0.09
TOTALS	**179**	**204.2**	**1.00**	**1.00**

TABLE 8: The type of preparation for all bushmeat samples and kilograms arriving in Swiss airports during this study.

Type of Presentation	Number of Samples	Weight (in kilograms)	Proportion of samples	Proportion of kilograms
Smoked/Dried	107	90.9	0.60	0.45
Fresh/Raw	64	106.3	0.36	0.52
Cooked/Spiced	8	7.0	0.04	0.03
TOTALS	**179**	**204.2**	**1.00**	**1.00**

TABLE 9: A combination of Preparation and Presentation for Bushmeat Samples and Kilograms; when combined, the type of preparation and presentation for sampled bushmeat shows that close to half the bushmeat samples (47%) arrived as smoked bushmeat pieces, and a substantial proportion (35%) was found as fresh carcasses or pieces.

Preparation and Presentation	Smoked/Dried		Fresh/Raw		Cooked/spiced		TOTAL	
SAMPLES	Number of samples	Proportion of samples	Number of samples	Proportion of samples	Number of samples	Proportion of samples	Number of samples	Proportion of samples
Pieces	84	***0.47***	39	***0.22***	4	0.02	**127**	***0.71***
Whole carcasses	15	0.08	23	***0.13***	0	0.00	**38**	**0.21**
Partial carcasses	8	0.04	2	0.01	4	0.02	**14**	**0.08**
TOTAL	**107**	**0.60**	**64**	**0.36**	**8**	**0.04**	**179**	**1.00**

Preparation and Presentation	Smoked/Dried		Fresh/Raw		Cooked/spiced		TOTAL	
KILOGRAMS	Kilograms	Proportion of kilograms	Kilograms	Proportion of kilograms	Kilograms	Proportion of kilograms	Kilograms	Proportion of kilograms
Pieces	44.1	0.22	50.9	0.25	5.4	0.03	**100.4**	**0.49**
Whole carcasses	36.4	0.18	50.0	0.25	0.0	0.00	**86.4**	**0.42**
Partial carcasses	10.5	0.05	5.4	0.03	1.6	0.01	**17.4**	**0.09**
TOTAL	**90.9**	**0.45**	**106.3**	**0.52**	**7.0**	**0.03**	**204.2**	**1.00**

FIGURE 6: Identifying Bushmeat preparation; Bushmeat most often arrives as either smoked or fresh/raw meat. **ROW 1: Left:** A smoked monkey head (*Cercopithecus* spp.) and multiple pieces from a confiscation that included >75 bushmeat pieces and had 4 wild species present (3 of which were CITES-listed). Smoked preparations typically have a 'blackened' look to the skin as seen in this photo, while the meat inside is cooked to varying degrees, depending upon the heat of the fire and the length of cooking time. **Right:** A *Cercopithecus* monkey carcass that has been pieced; the skin has been smoked (to remove the hair) but the meat inside is fresh/raw. **ROW 2: Left:** Whole fresh/raw carcasses of African brush-tailed porcupines (*Atherurus africanus*) *vs.* **Right:** Smoked African brush-tailed porcupine carcasses that have been halved and opened to support the weight of the carcass during the smoking process, which has also dried the meat. This type of smoked meat is then made palatable by later reconstituting it in water inside a stew type preparation. **ROW 3:** A comparison of raw (left), cooked (center), and smoked (right) cane rat (*Thryonomys swinderianus*).

All photos in this report were taken from bushmeat confiscated in Swiss Airports during this study

FIGURE 7: Identifying Bushmeat - whole carcasses may sometimes be recognizable to species: Examples of whole bushmeat carcasses found during the study; **ROW 1:** A confiscation of 7 whole, fresh carcasses; identified with DNA as 1 pangolin (*Manis* spp.; 1st on left), 1 African palm civet (*Nandinia binotata;* 2nd from right) and 5 African brush-tailed porcupines (*Atherurus africanus*). **ROW 2:** A confiscation of CITES-listed fresh pangolins (*Manis* spp.), a smoked African Guenon carcass (*Cercopithecus* spp., far right), and bagged, pieced African brush-tailed porcupine (*A. africanus*). **ROW 3:** Two CITES-listed whole, smoked pangolin carcasses (*Manis* spp.). **ROW 4:** Non-CITES species carcasses: From **Left to Right:** a small carnivore, the African Palm Civet (*Nandinia binotata*), and 4 rodents; a fresh cane rat carcass (*Thryonomys swinderianus*), and 3 photos featuring African brush-tailed porcupine carcasses (*A. Africanus*)*;* rodents were the most common Non-CITES animal group in the study.

All photos in this report were taken from bushmeat confiscated in Swiss Airports during this study

FIGURE 8: Identifying Bushmeat - Partial Carcasses: Partial carcasses are less easily recognized, but still retain some identifying features. **ROW 1: Left:** Partial carcass of a smoked, CITES-listed African clawless otter (*Aonyx capensis*), and **Center** and **Right:** Fresh and smoked African brush-tailed porcupines. **ROW 2: Left** and **Center:** Partial, smoked pangolin carcasses, and **Right:** A dried/smoked partial carcass of an African Brush-tailed porcupine.

FIGURE 9: Pieced Bushmeat - examples of cryptic/pieced bushmeat: Bushmeat arriving in Switzerland is most often in pieces that vary in appearance and size and cannot be recognized to species. Pictured here are CITES-listed species found as pieced bushmeat. **ROW 1: Left:** Fresh Guenon monkey torso (*Cercopithecus* spp.) **Center:** Cooked Blue duiker (*Philantomba monticola*), and **Right:** Cooked, spiced Bay duiker (*Cephalophus dorsalis*). **ROW 2: Left** and **Center:** Pieced, spiced pangolin meat (*Manis* spp.), and **Right:** Fresh Blue duiker (*Philantomba monticola*).

All photos in this report were taken from bushmeat confiscated in Swiss Airports during this study

FIGURE 10: Characteristic Features of Bushmeat; Pieced bushmeat often includes features such as heads, appendages (paws/hands/feet/hooves), the presence of bones in the meat (especially ribs/vertebrae and long bones in the legs/arms), the presence of a pelt or skin, and a foul odor, mold or discoloration due to poor preservation. All are indicators of bushmeat. **ROW 1: HEADS of CITES-listed species; Left** and **Center (left):** *Cercopithecus* spp. fresh and smoked heads, **Center (right):** Blue duiker head (*Philantomba monticola*), and **Right:** African forest hinge-back tortoise head (*Kinixys erosa*). **ROW 2: HEADS: Left:** CITES-listed pangolin head rubbed with spices, and 3 examples from non-CITES species; **Center (left):** A smoked Cane rat head and torso, **Center (right)**: A halved, smoked/dried African brush-tailed porcupine head and **Right:** a smoked whole porcupine head. **ROW 3: Left:** a *Cercopithecus* monkey head and arms, smoked, and **Right:** A pile of fresh/raw African forest hinge-back tortoise heads and legs (*Kinixys erosa*). The two photos featured in ROW 3 represent only a portion of the largest bushmeat confiscation found during this study, which included multiple (>75) pieces, and from which at least 3 CITES-listed species were identified, including the following pieces; 1 head, at least 4 appendages and misc. pieces from *Cercopithecus* monkeys, 2 heads and at least 10 legs from forest hinge-back tortoises (*K. erosa*), and 1 head and multiple pieces from Blue duiker (*P. monticola*). Non-CITES species were also present, including at least 6 pieces from Sitatunga (*Tragelaphus spekii*) – while 33 pieces were sampled, the majority of the pieces in this confiscation were not sampled, so that the presence of other species is possible.

All photos in this report were taken from bushmeat confiscated in Swiss Airports during this study

FIGURE 11: Characteristic Features of Bushmeat: APPENDAGES (paws/hands/feet/ hooves) are often present**; ROW 1: Left** and **Center:** Smoked *Cercopithecus* monkey arm and hand (with opposable thumb visible), and **Right:** the paws of a smoked African Clawless Otter (*A. capensis*), which resemble a primate's hands. **ROW 2: Left** and **Center:** African forest hinge-back tortoise (*K. erosa*) front and back leg detail, and **Right:** The tail and back foot of an African brush-tailed porcupine (*A. Africanus*).

FIGURE 12: Characteristic Features of Bushmeat: BONES are often present in bushmeat – especially the **RIBS** and **VERTEBRAE** of the torso. **ROW 1: Left:** a *Cercopithecus* ribcage, **Center:** Ribs and vertebrae from Red-flanked duikers (*Cephalophus rufilatus*) and **Right:** Ribs from a Red river hog (*Potamochoerus porcus*). **ROW 2: Left:** Red river hog ribs, **Center:** From left to right, Red river hog ribs, a Peter's duiker (*C. callipygus*) ribcage/leg, and Blue duiker (*P. monticola*) ribs, and **Right:** Walter's duiker (*P. walteri*) ribcage and pieces.

All photos in this report were taken from bushmeat confiscated in Swiss Airports during this study

FIGURE 13: Characteristic Features of Bushmeat: BONES are often present in bushmeat - especially the **LONG BONES IN THE LIMBS. ROW 1:** various duiker legs; **Left** and **Center (left):** Red-flanked duiker legs (*Cephalophus rufilatus*), **Center:** a Blue duiker leg, and **Center (right)** and **Right:** Long bones of the legs from Red river hogs (*Potamochoerus porcus*).

FIGURE 14: Characteristic Features of Bushmeat: The presence of a **PELT/HAIR** or **SKIN/HIDE** attached to the meat often indicates bushmeat: **ROW 1: Left:** Red river hog smoked meat with pelt (note the typical cane rope handle attached for hanging the meat at a roadside stand or market), **Center:** Fresh Blue duiker (*P. monticola*) meat with the pelt still present, and **Right:** Common duiker (*Sylvicapra grimmia*) legs, with pelt present.

FIGURE 15: Characteristic Features of Bushmeat: MOLD or **DISTRESS/DISCOLORATION** is often present on bushmeat due to poor preservation techniques; **ROW 1: Left:** Mold spots on an African brush-tailed porcupine, **Center:** Mold on smoked cane rat pieces and **Right:** Smoked dried Cane rats with mold spots. **ROW 2: Left** and **Center:** Cane rat pieces with mold visible, and **Right:** Discoloration and mold on smoked/dried porcupine pieces.

All photos in this report were taken from bushmeat confiscated in Swiss Airports during this study

FIGURE 16: Bushmeat packaging; Bushmeat most often arrives in ***non-commercial packaging*** **-** it is typically wrapped in plastic bags, wax paper, newspaper or other types of paper, or in aluminum foil, or is carried in non-commercial plastic containers. **ROW 1: Bushmeat in plastic bags**, the most common type of presentation; **Left** and **Center (left):** African brush-tailed porcupines, **Center (right):** Giant African Land Snails (*Achatina or Archachatina* spp.), and **Right:** Gaboon Viper (*Bitis gabonicus*) wrapped in plastic bags. **ROW 2: Left** and **Center:** A bushmeat confiscation wrapped in **wax paper** and **plastic**; this was concealed inside a bag of peanuts within a large consignment of food legally imported from Cameroon (SDA 2011), and **Right:** a whole, smoked cane rat, wrapped in **brown paper**. **ROW 3:** Smoked fish and Cane Rat pieces wrapped in **newspaper** and **cloth**, and **ROW 4: Left:** pieced Pangolin (*Manis* spp.) in **aluminum foil** and plastic, **Center:** African snails in aluminum foil and plastic, and **Right: Non-commercial plastic containers are also used**: Porcupine pieces in a pepe 'soup'; bushmeat is often pieced and put into a soup or stew type preparation containing greens and spices, and carried in non-commercial plastic containers. [***Note:*** *in some photos, bushmeat has been placed on black plastic or aluminum foil for sanitary reasons during sample collection*]

All photos in this report were taken from bushmeat confiscated in Swiss Airports during this study

RESULTS:
The Size of Bushmeat Confiscations in Switzerland

IV. The Size of Bushmeat Confiscations – Trends in This Study

Illegal Meat and Bushmeat Confiscations over the Past 5 Years – How Big are They?

The customs records for all meat and milk confiscations for 2008-2012 were provided for use in this study. A prior examination and analysis of these records before the current study (from Customs records through 2011) allowed us to look at trends in illegal meat smuggling by passengers for a large sample size. A study of illegal meat and bushmeat imports from these earlier records was also published by Vetsuisse at the University of Bern (Falk et al 2013).

The amount of meat (in kilograms) that passengers smuggle into Zürich and Geneva airports in their luggage is not normally distributed; instead, the data shows that the majority of passengers tend to smuggle small amounts of meat (between 1.0 and 3.0 kilograms) with rarer incidences of passengers carrying large amounts. In 2012, over 80% of the total meat confiscations were <4 kg and the average size for all meat confiscations in the 2012 Customs records was **2.77 kg ± 0.06 kg**. This trend in the amount of meat smuggled by passengers into Swiss airports is illustrated in **FIGURE 17**.

Bushmeat is Heavier than All Other Types of Meat Confiscations

We compared the distribution of meat kilograms from all bushmeat confiscations collected during this study to those confiscations collected during the study that contained no bushmeat (using data from both control days and from the 2012 suspected bushmeat). Overall, ***confiscations that contained bushmeat were larger than those confiscations that did not contain bushmeat***. Confiscations containing bushmeat weighed on average significantly more (**7.69 kg ± 1.62 kg**, n=27 confiscations) than confiscations which contained no bushmeat (**2.55 kg ± 0.49 kg**, n=31 confiscations). A Kolmogorov-Smirnov two-sample test, used due to heterogeneity of variances between these two groups, showed that this difference was highly significant (*K-S Z* = 1.956, p=0.001), meaning that passengers who were smuggling bushmeat into Switzerland tended to carry larger amounts of meat than those passengers smuggling non-bushmeat types of meats. Results are presented in **FIGURE 18** and in **TABLE 10** and **FIGURE 19**.

This trend was also evident in an examination of combined 2012 Customs records from Zürich and Geneva Airports. The average amount of meat in confiscations described as bushmeat or wild meat when these two airports were considered together was significantly higher (**6.05 kg ± 1.17 kg**) than the average size for all other meat confiscations (**2.71 kg ± 0.05 kg**) (*K-S Z* = 1.822, p=0.003). Results are presented in **TABLE 11** and **FIGURE 20**.

These results show that bushmeat smugglers tend to carry larger amounts of meat into Switzerland than those passengers smuggling other types of meats. The fact that bushmeat confiscations tend to be larger suggests that bushmeat smuggling may not be only for personal consumption, but could also include some amount of meats for others, or meats for sale.

FIGURE 17: The total amount of meat (in kg) for all meat confiscations smuggled by passengers into Swiss airports in 2012 from Swiss Customs Records. Most passengers smuggle small amounts of meat (between 1-3 kg).

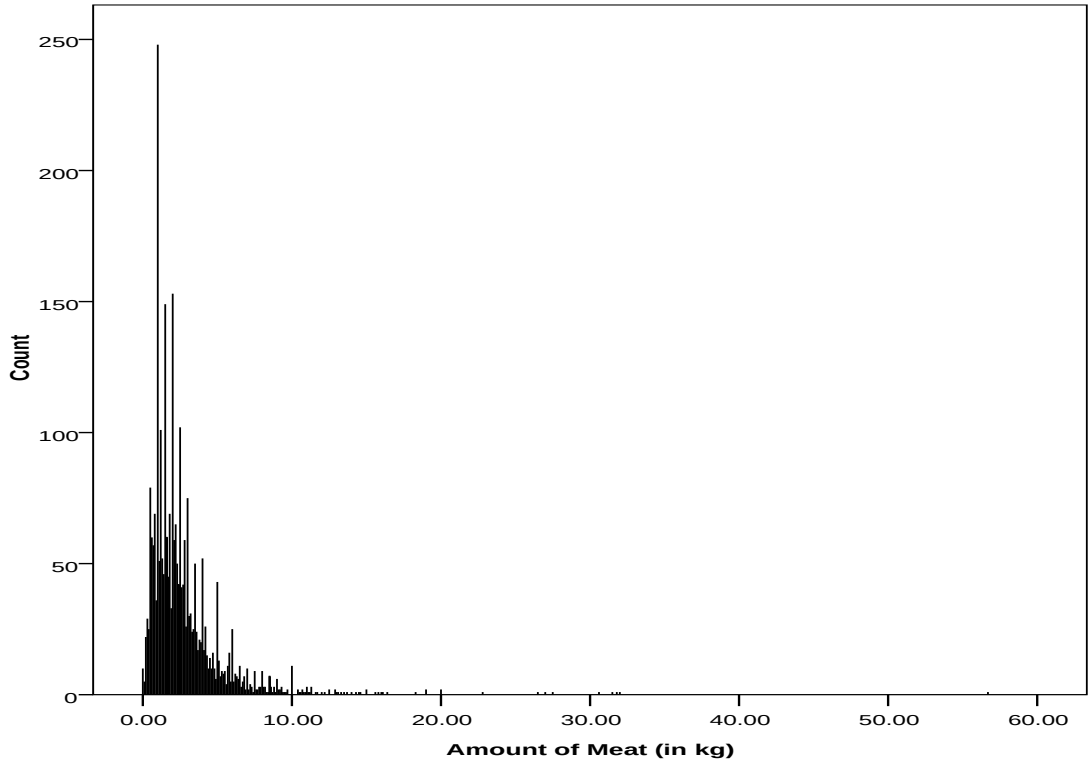


FIGURE 18: Confiscations of bushmeat *vs.* non-bushmeat in this study. Bushmeat confiscations were significantly heavier than other types of meat confiscations.

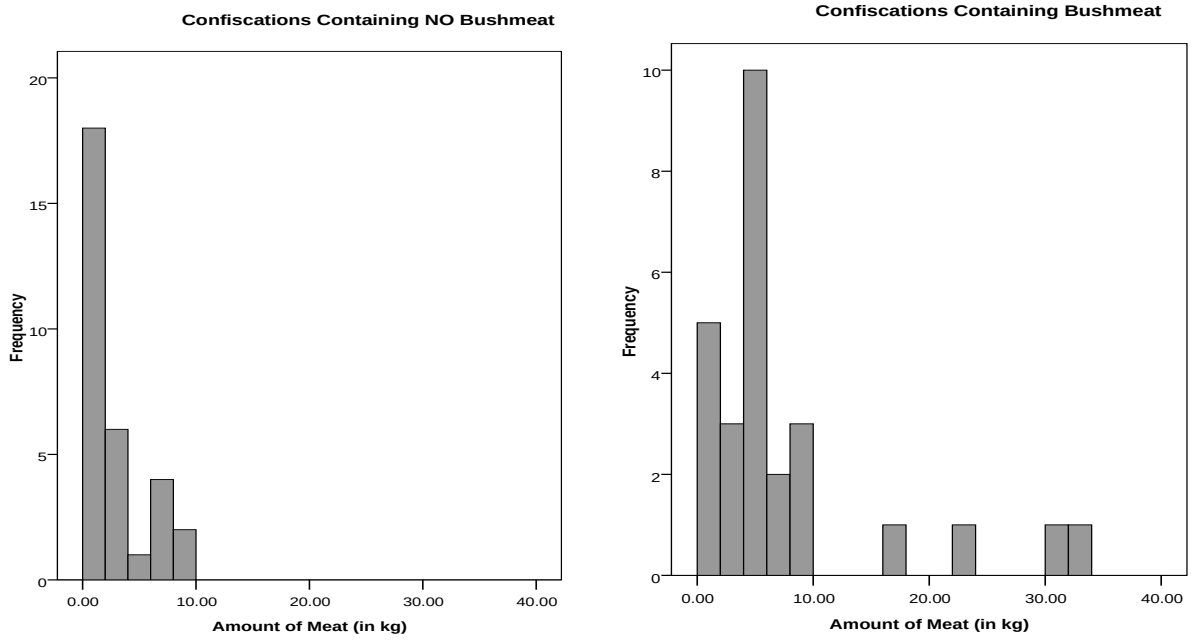


TABLE 10: ***RESULTS FROM THIS STUDY*** **-** Two Sample Kolmogorov-Smirnov test results from ***this study*** for confiscations containing bushmeat *vs.* those that contained no bushmeat.

Descriptives

	N	Mean (in kg)	Std. Error
Confiscation contains BUSHMEAT	31	7.685	1.622
Confiscation contains NO bushmeat	27	2.545	0.479
TOTAL	58		

Test Statistics (a)

		Amount of Meat (in kg)
Most Extreme Differences	Absolute	.515
	Positive	.515
	Negative	.000
Kolmogorov-Smirnov Z		1.956
Asymp. Sig. (2-tailed)		.001

(a) Grouping Variable: ***This Study;*** Confiscations containing bushmeat *vs.* Meat confiscations with no bushmeat

FIGURE 19: A boxplot of the mean amount of meat (in kg) from ***this study*** for confiscations containing bushmeat *vs.* those confiscations which contained no bushmeat.

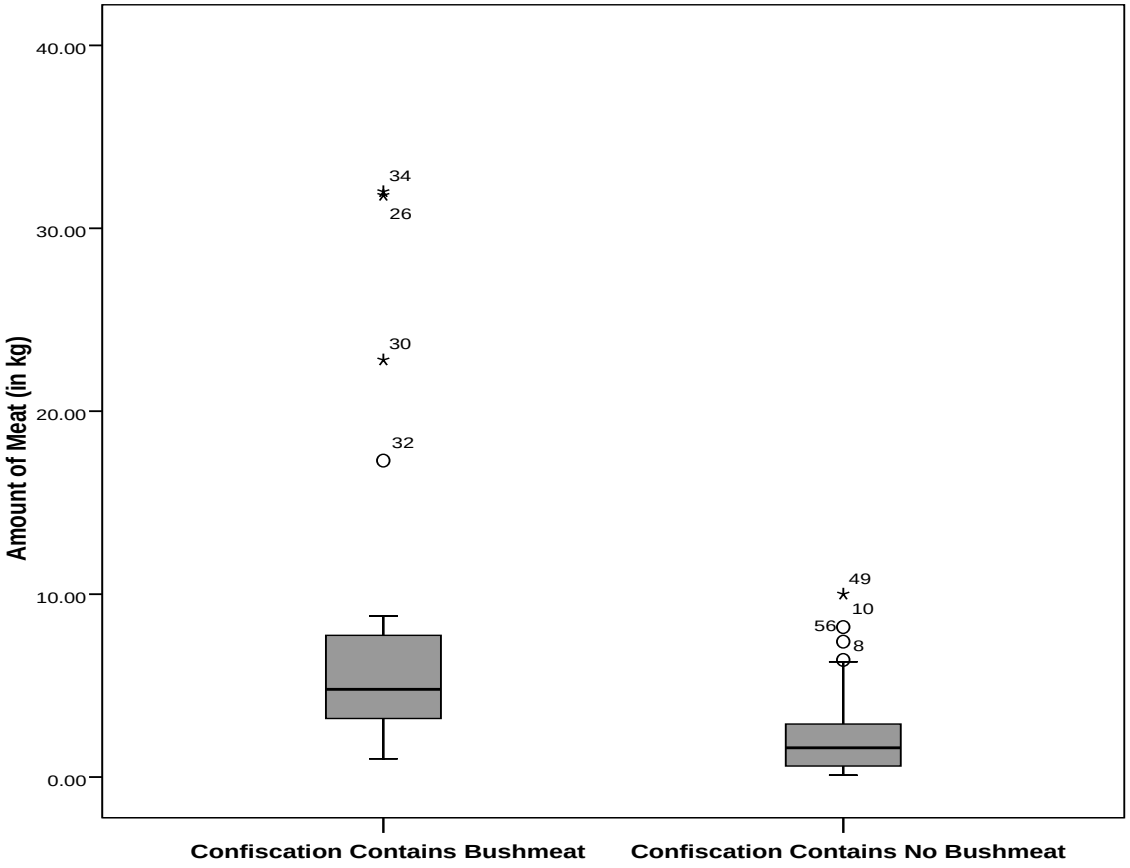


TABLE 11: ***CUSTOMS RECORDS 2012*** - Two Sample Kolmogorov-Smirnov from the ***2012 Swiss Customs records***; Test results for confiscations recognized by Swiss Customs agents in 2012 as bushmeat or wild meat *vs.* all other meat confiscations.

Descriptives

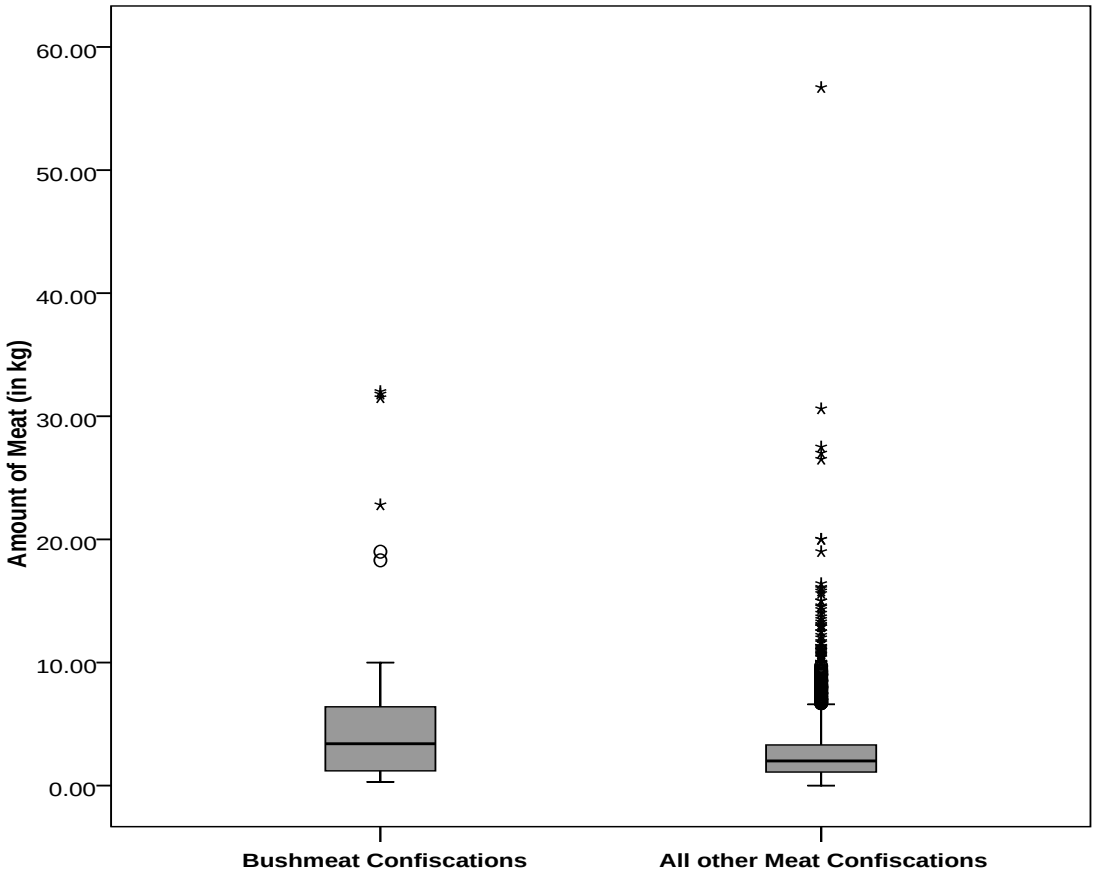
	N	Mean (in kg)	Std. Error
Confiscation recognized as containing BUSHMEAT or WILD meat	49	6.049	1.169
All Other Meat Confiscations	2687	2.709	0.052
TOTAL	2736		

Test Statistics (a)

		Amount of Meat (in kg)
Most Extreme Differences	Absolute	.263
	Positive	.263
	Negative	-.060
Kolmogorov-Smirnov Z		1.822
Asymp. Sig. (2-tailed)		.003

(a) Grouping Variable: Customs Records 2012; Bushmeat Confiscations *vs.* All Other Meat Confiscations

FIGURE 20: A boxplot of the mean amount of meat for confiscations recognized by Swiss Customs as bushmeat or wild animal meat *vs.* all other meat confiscations from the Customs Records of meat confiscations in 2012.



RESULTS:
DNA Identification of Species at Risk from the Bushmeat Trade in Switzerland

V. DNA Analysis of Bushmeat for Species Identification

Identification of Species: Success of the DNA Analysis

Using the DNA methodologies described in Morf et al (2013), we were able to successfully identify the majority of our bushmeat samples; 90% of the meat samples (224 of the 250) were identified to either the species or genus level. Meat samples from confiscations were identified to the species level (samples showed a sequence homology of ≥98% to a reference sequence from the database) for the majority of the DNA tested meats (76%, or 190 of 250 samples)and for 14% of the samples (34 of the 250), DNA analysis identified samples to the genus level (sequences showed <98% of sequence homology to those in the database). The DNA failed to identify species for only 10% of samples, and the majority of these were from commercially processed meats on control days. The DNA technique utilized appears to be highly robust; identifications were possible even with degraded samples and long storage periods, marking this as a powerful tool to identify bushmeat, especially those CITES- listed species being smuggled as bushmeat. **TABLE 12** summarizes the various categories of outcomes for the DNA analyses.

Genus Level and Morphological Identifications

Some samples were identified in the DNA analyses only to the genus level because of inadequate representation of species in the online sequence database; there are a number of little-studied species for which the online database has no DNA sequences, or DNA sequences for only a small number of individuals. This results in less certainty in the identification because the full genetic variation in the species is not present in the database, and was true of samples identified only to genus level in this study.

The majority of samples identified only to the genus level in this study were either pangolins (*Manis* spp.; 13 samples), for which few individuals are present in the online database, or Guenon monkeys (*Cercopithecus* spp.; 12 samples), a species-rich genus that is also not well represented as many of the species are not present in the online database. All of the *Manis* spp. identified in the DNA analysis came from whole or partial carcasses, or multiple pieces for which heads or other identifying structures were present, so that identification could be confirmed as *Manis* morphologically. Photos were taken of all bushmeat sampled for this study, and photos from those samples identified as *Manis* spp. were sent to the IUCN Pangolin specialist group for possible identification to the species level (results of photo examinations are discussed on page 56). The primates in the study were identified only to the genus level in the DNA analysis as *Cercopithecus* spp. and the smoking process had removed hair and other features which would allow for visual identification to the species level. However, all were morphologically identifiable as a species of long-tailed monkey, weighing between 2-6 kilograms, and originating from a West or Central African country (for 1 case, it was also possible the specimen had originated in East Africa).

The remaining genus level identifications in the DNA analysis were from pieces that had no identifying features present, including 5 samples which were identified as *Atherurus* spp., but did not match with *Atherurus africanus* in the online DNA database. We included these 5 samples with results for *Atherurus africanus* for this report as this is the only species of *Atherurus* porcupine known to exist in West/Central Africa (the region this meat arrived from) and samples did not match the Crested Porcupine (*Hystrix cristata*), the only other genus of porcupine occurring in this region. However, it must be noted that these 5 samples, identified only as *Atherurus* spp., were genetically distinct from *Atherurus africanus*. There were also 3 samples from Africa identified in the DNA analyses as either *Bos taurus* (the domestic

cow) or *Bos indicus* (an African breed of domestic cow), and 1 sample identified only as *Himantura* spp. (a species of Stingray from Asia).

DNA Analysis Did Not Proceed – Commercially Processed Meats

Meats for which DNA testing did not proceed included those for which too little DNA was present in the sample, or a mixture of DNA was present in the sample (26 samples, totaling 16.74 kg). However, 4 of these samples (1.73 kg) were identified as red river hog (*Potamochoerus porcus*) based on morphological similarities of the pelt to other pieces within the same confiscation that were identified in the DNA analysis. The remainder of the samples that were not identified in the DNA analyses came from meat pieces that contained no identifying features, so that species identifications could also not be determined morphologically (n=22, 15.01 kilograms from 17 different confiscations).

Commercially processed and packaged meats were the most likely to fail DNA analysis. The majority of samples for which DNA was unable to be extracted in this study, or those for which a mix of DNA was present, were commercially processed items collected on control days (18 of 26, or 70% of the unidentified meats). All of the cases described as 'commercially processed' involved cooked and/or dried meats or a mixture of different meats in one package, and sometimes in sauces or heavily spiced. Examples of commercially processed meats that were not identified in the study include canned meats, dried commercial jerky-type meat products, commercial soup or pasta preparations with dried meat pieces, and wursts. These types of products or processing may make DNA extraction difficult. **TABLE 12** demonstrates that DNA analyses were less successful identifying a number of commercially processed meats from the control days, but succeeded with the majority of bushmeat samples.

Animals Groups at Risk from the Bushmeat Trade in Switzerland

There were at least 37 different species (domestic, fish and wild) found being smuggled into Switzerland during this study and confiscated by Customs. Because some meat was identified only to the level of class, family or genus, it is possible there were as many as 45 different species found during the study.

DNA results identified 16 different wild species, and 2 wild genera (with anywhere from 2-6 species present in these genera). Identifications based on morphology added 5 to 7 more species. This means that at least 23 wild species were identified during this study, although as many as 29 different wild species are possible. Mammals were the most plentiful wild animal group found as bushmeat in Swiss airports, making up 92% of the wild meat kilograms. The most common mammal group were rodents (55% of the total wild meat), followed by pangolins (14%), duikers (12%), and primates (6%). Other mammals found smuggled in lesser amounts included wild pigs (2%), small carnivores (2%), and other antelope (1%). Additional animal groups found and considered bushmeat in this study included reptiles (4% of total wild meat), invertebrates (snails and insects, 3%) and birds (1%). Results are presented in **TABLE 13** and in **FIGURE 21.** The majority of the wild species identified in this study came from Africa. In total, 15-20 mammalian species, 3 reptile species, and 3-5 invertebrate species from Africa were identified as arriving as bushmeat in Swiss airports. All bushmeat confiscations from the ongoing collection of suspected bushmeat by Customs agents in 2012 originated in Africa. Control day confiscations of bushmeat included two of the more frequently found bushmeat species in this study (the African Giant Land Snail and the African brush-tailed porcupine), as well as the only wild species from outside of Africa (2 bird species from Asia). All wild species identified during the study can be viewed in **TABLE 15**.

A number of wild fish species were also identified in the study, but were not considered bushmeat, as up to 20 kg of wild fish can be carried by passengers. Domestic species were also identified in our DNA

analysis, and those wild fish and domestic species found during the study, including their regions of origin, can be viewed in **TABLE 16**.

CITES-Listed Species at Risk from the Bushmeat Trade

Using the CITES searchable database (CITES 2013c)[4] and the region of origin of the sample, we determined CITES listings for all wild species identified in our samples. We also determined the IUCN Red Data Listing for all species (IUCN 2013a). There were 3 cases of note for which the CITES-listing of the species could not be determined; 1 confiscation of a smoked carcass was identified in our DNA analysis as the Walter's duiker (*Philantomba walteri*) – this duiker was only recently discovered (Colyn 2010) and therefore has not yet been evaluated by the IUCN or CITES. The second case was a confiscation of crocodile skin phone covers, which were identified only to the family level (*Crocodylidae*) as samples were not able to be collected. The third were the 3 species of invertebrates found during the study, which were not sampled and were identified only as Class *Insecta*.

CITES listings were able to be determined for 170 of the 179 bushmeat samples; 61 of these samples, originating from 6-10 different species, came from ***species that are listed in the CITES Appendices***. This means that ***over one-third (35%) of the samples identified as bushmeat in this study and 30% of the total kilograms identified as bushmeat came from CITES-listed species***. A listing of the species found in Swiss airports, including those CITES-listed species found during the study, can be viewed in **TABLE 16**.

Because the presence of CITES-listed species arriving as illegally smuggled bushmeat in Switzerland was alarming, we examined this result further. We compared all confiscations in our study which contained bushmeat and for which the CITES-listing of wild species present in the confiscations was known. Two confiscations were dropped from this analysis (i.e. those already mentioned above – 1 confiscation of the recently discovered Walter's duiker, which has not been evaluated by IUCN/CITES, and 1 confiscation identified only as *Crocodylidae*, for which CITES-listing could not be determined). We divided these bushmeat confiscations into two categories; 1.) ***CITES-listed species were present*** in the confiscation or 2.) ***No CITES-listed species were present*** in the confiscation. A comparison of the weight of the confiscations in these two categories yielded a surprising result; while sample size is small, confiscations within which CITES-listed species were present weighed on average significantly more (**16.3 kg ± 3.7 kg**, n=9 confiscations) than confiscations in which no CITES-listed species were present (**4.8 kg ± 0.6 kg**, n=16 confiscations). A non-parametric Kolmogorov-Smirnov two-sample test showed that this difference was significant (*K-S Z* = 1.6, p=0.012); *passengers smuggling bushmeat that included CITES-listed species tended to carry more meat*. This surprising result can be viewed in **TABLE 14** and in **FIGURE 22**.

Species Specific Results

Below is a brief summary of the results specific to those species which were identified as at risk from the bushmeat trade into Switzerland, including those listed in the CITES appendices, which we consider to be at highest risk. **TABLE 15** includes the list of all wild species found during the study, including the

[4] The CITES searchable database of species (formerly http://www.cites.org/eng/resources/species.html) was recently replaced by Species+ (http://www.speciesplus.net), a new online resource through UNEP-WCMC (CITES 2013e). Species+ provides comprehensive information on globally protected species, including all species covered by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Convention on the Conservation of Migratory Species of Wild Animals (CMS), and those species included in EU Wildlife Trade Regulations (UNEP-WCMC 2013b, 2013c).

number of confiscations within which each species was found, the total weight (in kg) for each species, and the regions from which the meat originated.

Primates

As noted in our introduction, primates were considered an indicator species in this study because all primates are listed in the CITES appendices and are known to be especially vulnerable to the wildlife trade in Africa. For this reason, we expected the arrival of primate bushmeat in Swiss Airports to be a rare occurrence. Instead, primates were found in 3 separate confiscations in 2012, and ranked 4th highest in total kilograms (12.02 kg), representing 6% of the total bushmeat kilograms found in this study. All of the primates found during the study were species of *Cercopithecus* monkeys (Oates et al 2008), identified only to the genus level in the DNA analyses, but representing at least 1 and possibly 3 species. Of these confiscations of primates, 1 monkey arrived as a complete/intact smoked carcass, 1 as a fresh, pieced carcass, with head, limbs, torso, and tail present, and the third as a smoked, pieced carcass, including a head, at least 4 appendages, a ribcage, and several pieces, of which one may have been a fifth appendage. This third monkey arrived in our largest confiscation (>75 pieces), from which 10 of 33 sampled pieces (30%) were identified as *Cercopithecus* spp. and many pieces were not sampled, so it becomes possible there was more than one monkey present in the confiscation.

Pangolins

Pangolins were the most at-risk CITES-listed animal group identified in this study. At least 8-9 whole and partial pangolin carcasses were confiscated, and several pieced carcasses representing at least at least 7 more pangolins were confiscated; this represents at least 16 pangolins with an estimated total weight of 28.08 kilograms. While our samples were identified only to the genus level in the DNA analysis, the origin of all flights carrying smuggled pangolins was Cameroon. We can therefore conclude that the pangolins found in this study were most likely to be 1 of 3 species that occurs in West/Central Africa; the tree pangolin (*M. tricuspis*), the long-tailed pangolin (*M. tetradactyla*), or the giant pangolin (*M. gigantea*) (Hoffmann 2008b, 2008c, 2008e). Pangolins have very distinctive morphological features and photos of all pangolin specimans were submitted to the IUCN Pangolin Specialist Group (IUCN-SSC PangolinSG 2013). Identifications from these photos were based on a number of morphological characteristics, including the body size of the specimens, the size and patterning of the scales, the lack of scales on the lower section of the forelimbs, and the length of the tail, and suggested that all of the specimens found during our study were likely to be the African Tree pangolin (*Manis tricuspis*) (IUCN Pangolin Specialist Group/Challender and Pietersen, *pers. comm*.), also known as the White-Bellied Pangolin or *Phataginus tricuspis* (Gaudin 2009).

Duikers

Duikers are a small African forest antelope (IUCN SSC Antelope Specialist Group 2008a, 2008b, 2008c) and were the third most at risk type of mammal from the bushmeat trade in Switzerland. Species from *all three duiker subfamilies* were found (*Cephalophus*, *Philantomba* and *Sylvicapra*) and more species of duiker were found during this study than any other mammal species; 7 species of duiker were identified in the DNA analyses, including 2 species listed in CITES Appendix II, and 5 of their sister taxa. The blue duiker (*Philantomba monticola*) and the bay duiker (*Cephalophus dorsalis*) are both CITES-listed species. These two species, along with the Red-flanked duiker, (*Cephalophus rufilatus*), were among the top ten most frequently found species in this study. Another sister taxa to the bay duiker, the Peter's duiker (*Cephalophus callipygus*), was also found. Other duiker species included 2 sister taxa to the blue duiker; the Maxwell's duiker (*Philantomba maxwelli*), and the Walter's duiker (*Philantomba walteri*). The Walter's duiker is a recently discovered species that occurs in Togo, Benin and Nigeria (Colyn et al 2010) and was identified as the most frequently hunted bushmeat species in Southwestern Nigeria in a study

using the same DNA techniques utilized in this study (Olayemi 2011). The third duiker subfamily represented in this study was a Common duiker (*Sylvicapra grimmia*), found in a confiscation from the Democratic Republic of Congo.

Other Ungulates

Other ungulates found in this study included two types of artiodactyla; the Red River Hog (*Potamochoerus porcus*) and the Sitatunga (*Tragelaphus spekii*). The Red river hog is a species of wild pig from West and Central Africa rainforests (Querouil and Leus 2008; IUCN SSC Wild Pig Specialist Group 2013) and was found in 2 separate confiscations in this study. One antelope species, the Sitatunga (*Tragelaphus spekii*), also known as the Marshbuck or Bushbuck, comes from lowland forest or swamp/savanna areas of Africa (IUCN Antelope Specialist Group 2008d), and was present in 1 confiscation.

Reptiles

Three species of reptiles were found during this study, a species of tortoise, a species of snake, and a species of crocodile. All tortoises (family *Testudinidae*) are listed in either CITES Appendix I or II. A confiscation from Kenya (via a Cameroon flight) contained pieced tortoise meat of least 3 or more specimens (2 heads, at least 10 appendages, and various pieces were present – see photo on page 43). Our DNA results identified these as the Forest hinge-back tortoise (*Kinixys erosa*), a CITES Appendix II species of tortoise from African forests (Tortoise & Freshwater Turtle Specialist Group 1996). Two non-CITES species of reptiles were also found. The Gaboon viper (*Bitis gabonica*) is a savanna and forest dwelling venomous snake from Africa that was found in a passenger's luggage as 2 bags of chopped snake meat. Also discovered being smuggled into Swiss airports were a number of crocodile skin phone covers in a confiscation from South Africa (both real and counterfeit), visually evaluated as belonging to the family *Crocodylidae*.

Carnivores

Carnivores found in this study are represented by 2 species, one of which is CITES-listed; the African Clawless Otter (*Aonyx capensis*), included in CITES Appendix II. One subspecies of *Aonyx* (*Aonyx capensis microdon* (also considered under the taxonomic names of *Aonyx capensis congicus* or *Aonyx congica*), is found in a limited region and therefore rare, and is considered a CITES Appendix I animal (Hoffmann 2008a; Jacques et al 2009; IUCN Otter Specialist Group 2013a). The partial otter carcass found during this study arrived with pieced red river hog (*P. porcus*) and originated from an unknown West/Central African country. However, while our analyses did not identify bushmeat to the subspecies level, the Appendix I subspecies *Aonyx capensis microdon* is found in the Cameroon/ Nigeria/Congo region - the known origin of most bushmeat in this study and the suspected origin of this confiscation - making it possible this specimen could be an Appendix I CITES-listed species. The second carnivore in this study was the smoked carcass of an African palm civet (*Nandinia binotata*), a small, tree-dwelling carnivore that is currently undergoing local population declines due to habitat loss and hunting (Van Rompaey et al 2008).

Other Wild Species at Risk from the Bushmeat Trade in Switzerland

Rodents

Rodents were the most frequently found type of bushmeat in this study (55% of the total bushmeat). Our samples identified two different species being smuggled into Swiss airports; the African brush-tailed porcupine (*Atherurus africanus*) and the Greater Cane Rat (*Thryonomys swinderianus*) (Hoffmann and

Cox 2008, Hoffmann 2008c). The African Brush-tailed Porcupine was by far the most frequently found species during the study and was identified in more confiscations than any other bushmeat species (n=16 confiscations). The porcupine also had the highest total estimated kilograms (81.85 kg or 44% of the total wild meat kilograms in this study). If one considers that the brush-tailed porcupine weighs on average 2.75 kg (Amori and Gippoliti 2002; Mainka and Trivedi 2002), the meat in this study represents at least 30 individuals. The Cane rat ranked 2nd overall, being present in 8 confiscations (n=28 samples), with a total weight of 30.48 kilograms. These two rodent species were found on both our control days and during the 2012 collection of suspected bushmeat. Only one other species accomplished this; the Giant African Land Snail (*Achatina or Archachatina* spp.).

Invertebrates

Three to five species of wild invertebrates were collected during this study, including three confiscations containing Giant African Land Snails (*Achatina or Archachatina* spp.), a popular and commonly eaten wild snail species, collected from the forests in West and Central Africa (Herz 2013; Liess 2007). Species of insects are also known to be collected from the wild for human consumption and were found being smuggled into Swiss airports as food items in two confiscations in this study. Three bags of insect larvae from 2-3 unidentified species were considered only as Class *Insecta*. Confiscations of invertebrates are under the discretion of customs agents and TRACES (TRAde Control and Expert System 2013); if the necessary import paperwork is not in place, they are confiscated. In the customs confiscations records for 2008-2012, invertebrates were one of the more frequently found types of wild meat; close to 30% of confiscations were described by customs agents as invertebrates, or confiscations of other types of meat or bushmeat (i.e. mammalian, reptile, etc.) which also included invertebrates.

Birds

Birds were not common in this study, and the only wild bird confiscations during the study were also our only non-African wild species. Two confiscations of wild birds of Asian origin occurred during the study period; one was a confiscation of bird's nest soup, a soup made from the nests/saliva of the cave swift (*Aerodramus* spp.) (Bird Life International 2012a); this was considered bushmeat because it is an animal product for consumption, although it is not a meat item. The second bird species arrived as the only commercially packaged item considered in the study to be bushmeat; a can of meat from China (via a Middle Eastern flight) labeled 'chicken luncheon meat', but identified in the DNA analysis as a mallard duck (*Anas platyrhynchos*) (Bird Life International 2012b). While mallard ducks are sometimes captive-raised or farmed, we considered any species that occurs in the wild in the country in which the meat originated to have the potential to be bushmeat.

Fish and Domestic Species Found as Smuggled Meats

Fish

Wild fish were not considered bushmeat in this study; up to 20 kilograms of dried or eviscerated fresh fish is allowed in passenger luggage for personal consumption. Because of this, it was difficult to evaluate the threat to fish. While amounts larger than 20 kg are confiscated, species recognition is complicated because a large variety of species exist, and some fish species may be farmed rather than wild. However, the authors observed a number of passengers on control days, especially from flights of Asian and African origin, carrying suitcases filled with fish or fish products. While we did not collect samples from fish during the study, some of our sampled 'meat' pieces were later identified in the DNA analysis as coming from fish and in total, 5 different fish species were identified from confiscations that contained unrecognizable fish pieces mixed with other types of meats. Fish species identified during the

study included 2 African catfish species (*Clarias gariepinus* from an Ethiopian confiscation and *Clarias pachynema* from a Cameroon confiscation), 2 fish species from the North Atlantic ocean that were confiscated from Nigeria (*Brosme brosme* and *Molva molva*), and 1 species of stingray from Singapore (*Himantura* spp.). Visual identifications from confiscations that were over 20kg added 1-2 more species of commercially fished shrimp (family *Penaeidae*) confiscated from Brazil and Nigeria. Overall, 7 confiscations contained fish species and 9 samples were identified as fish. The confiscation from Singapore that was identified only to the genus level as a species of stingray (*Himantura* spp.) is notable because the genus *Himantura* includes a number of vulnerable and endangered species (IUCN 2013b). While this species was not included as bushmeat, it could well be an at risk species of fish. Results for fish species, including the region of origin of the meat, can be viewed in **TABLE 16**.

Domestic Species

DNA analyses also identified at least 7, and up to 8, different domesticated species being illegally smuggled as meats into Switzerland. The most common domestic animal meat found in our study was the cow (*Bos Taurus*), which was found in 18 confiscations, followed by the domestic pig (*Sus scrofa*), which ranked as the 2nd most frequent type of domestic meat and the chicken ranked 3rd (*Gallus gallus*). Interestingly, the water buffalo (*Bubalus bubalis*) ranked as the 4th most frequently found domestic species being illegally carried into Switzerland. While populations of wild water buffalo do exist in parts of Asia, the smuggled meats originated in Turkey and Morocco, where this species is farmed, but is not found in the wild, and these meats were therefore considered to have originated from a domestic species. Other domesticated species found illegally smuggled included the turkey (*Meleagris gallopavo*), the donkey (*Equus asinus*), and the goat (*Capra hircus*). Results for domestic species, including the region of origin for the meat, can be viewed in **TABLE 16**.

TABLE 12: Success rate of DNA identification; Results for samples which were analyzed in the DNA analyses (n=250), and for samples that were not included in the DNA analyses, but were visually identified (n=30).

Success of DNA Analysis	2012 ongoing bushmeat collection		Control Days		Grand Total	
	Number of samples	Weight (in kilograms)	Number of samples	Weight (in kilograms)	Number of samples	Weight (in kilograms)
DNA ID to species or genus level	163 (96%)	189.6 (99%)	61 (75%)	56.14 (79%)	224 (90%)	245.74 (94%)
DNA failed – (No DNA or mix of DNA)	6 (4%)	2.13 (1%)	20 (25%)	14.61 (21%)	26 (10%)	16.74 (6%)
SUBTOTAL	***169***	***191.73***	***81***	***70.75***	***250***	***262.48***
DNA analyses not attempted (visual identification only)	17	25.65	13	8.04	30	33.68
GRAND TOTAL	***186***	***217.37***	***94***	***78.79***	***280***	***296.16***

TABLE 13: Wild animal groups found as bushmeat in Swiss airports in 2012; 92% of samples were from mammals, 4% from reptiles, 3% from invertebrates, and 1% from birds.

Type of Animal	Number of Samples	Proportion of Samples	Estimated Kilograms	Proportion of Kilograms
Rodents (2-3 species)	72	0.40	112.33	0.55
Pangolins (1-3 species)	20	0.11	28.08	0.14
Duikers (7 species)	34	0.19	24.95	0.12
Monkeys (2-3 species)	12	0.07	12.12	0.06
Reptiles (3 species)	13	0.07	7.50	0.04
Wild pigs (1 species)	14	0.08	4.78	0.02
Small carnivores (2 species)	3	0.02	3.91	0.02
Insects (2-3 species)	3	0.02	3.76	0.02
Birds (2 species)	2	0.01	3.03	0.01
Snails (1-2 species)	5	0.03	2.70	0.01
Other antelope (1 species)	1	0.01	1.00	0.005
TOTAL	***179***	***1.00***	***204.16***	***1.00***

FIGURE 21: The estimated amount (in kg) for all animal groups/species identified during the study.

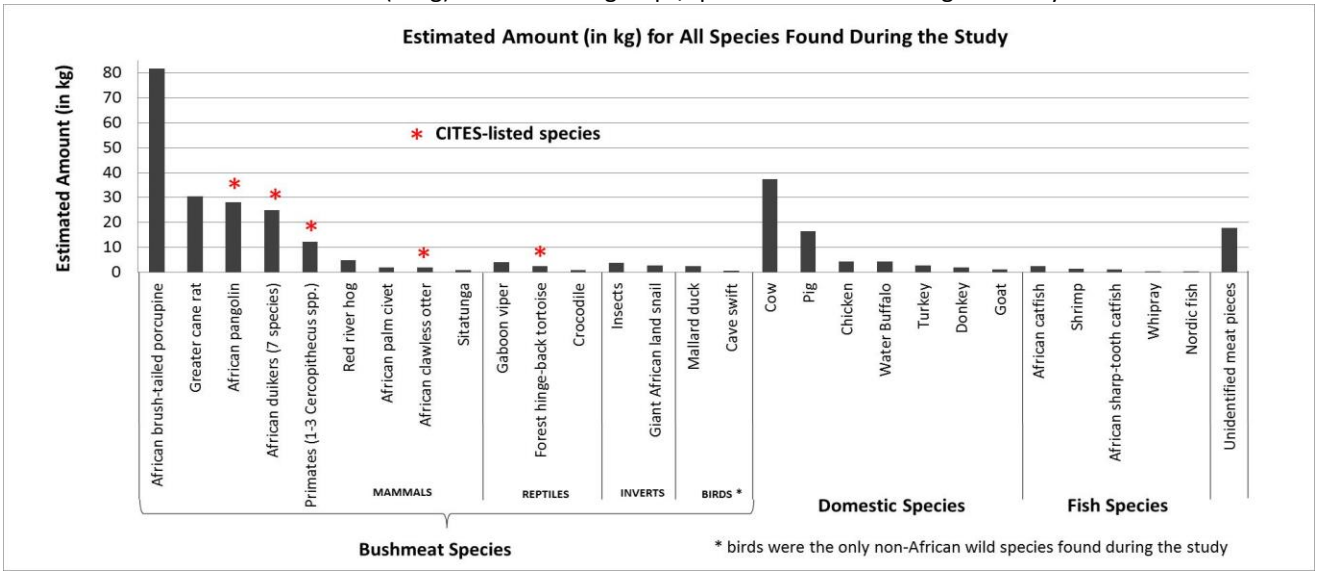


TABLE 14: All Bushmeat Confiscations: A comparison of the presence or absence of CITES-listed species in all bushmeat confiscations for which CITES-listings were known.

Descriptives

All Confiscations Containing Bushmeat	N	Mean (in kg)	Std. Error
Confiscation contained CITES-listed species	9	16.249	3.692
Confiscation contained no CITES-listed species	16	4.776	0.615
TOTAL	25		

Test Statistics (a)

		Amount of Meat (in kg)
Most Extreme Differences	Absolute	.667
	Positive	.667
	Negative	.000
Kolmogorov-Smirnov Z		1.600
Asymp. Sig. (2-tailed)		.012

(a) Grouping Variable: This Study; Presence *vs.* Absence of CITES-listed species for all bushmeat confiscations

FIGURE 22: All Bushmeat confiscations; a comparison of the weight of all bushmeat confiscations within which **CITES-listed species are present** *vs.* those with **no CITES-listed species present**. Confiscations containing CITES-listed species weighed significantly more than those bushmeat confiscations with only non-CITES species present.

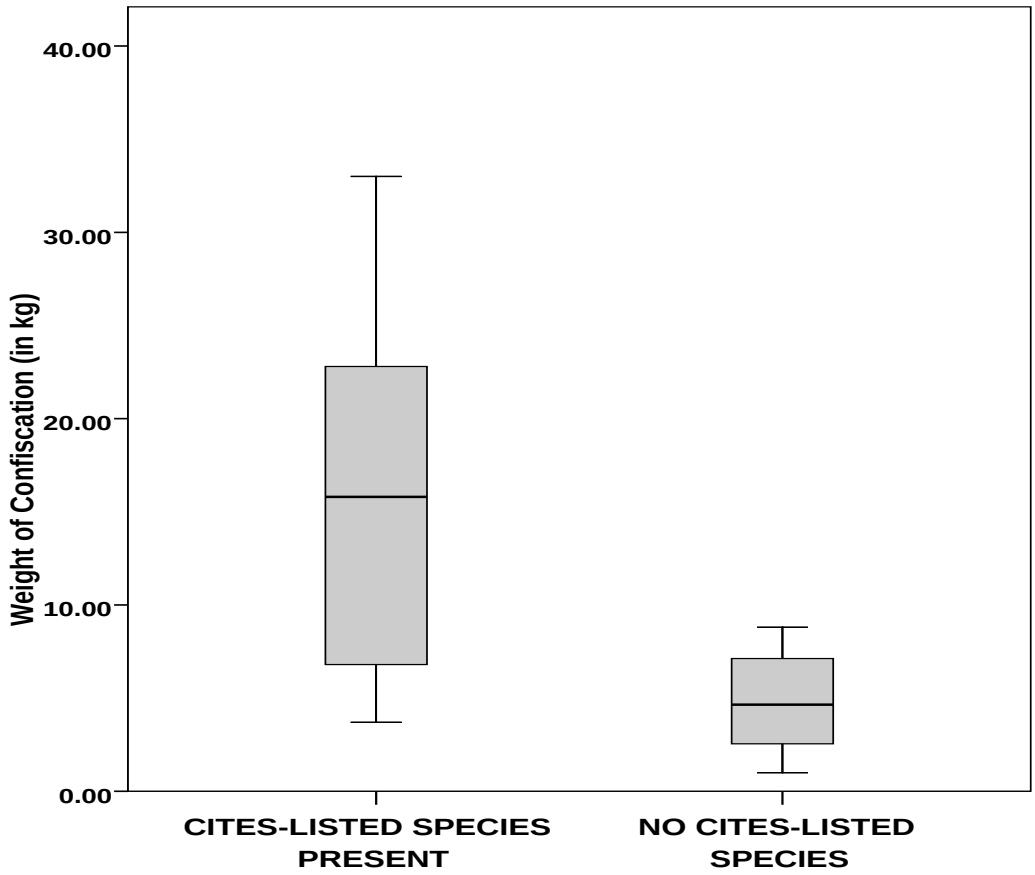


TABLE 15: Wild species found as bushmeat during our study, including the countries of origin of the meat.

COMMON NAME	*SPECIES*	*Number of samples*	*Number of confiscations*	*Weight in kilograms*	*CITES LISTING*	*Countries of Origin (listed from highest to lowest kg)*
CITES-LISTED SPECIES						
African pangolin	*Manis* spp. (1-3 species*)	*20*	*5*	*28.08*	*CITES Appendix II*	*Cameroon*
Blue duiker	*Philantomba monticola*	*13*	*3*	*12.20*	*CITES Appendix II*	*Kenya, Cameroon*
Guenons	*Cercopithecus* spp. (1-3 species**)	*12*	*3*	*12.12*	*CITES Appendix II*	*Cameroon, Kenya*
Bay duiker	*Cephalophus dorsalis*	*4*	*2*	*2.89*	*CITES Appendix II*	*Cameroon*
Forest hinge-back tortoise	*Kinixys erosa*	*10*	*1*	*2.40*	*CITES Appendix II*	*Kenya*
African clawless otter	*Aonyx capensis*	*2*	*1*	*1.85*	*CITES Appendix II*	*unknown African country*
SPECIES NOT CURRENTLY LISTED IN CITES APPENDICES						
African brush-tailed porcupine	*Atherurus africanus* (1-2 species***)	*44*	*16*	*81.85*	*not listed*	*Cameroon, Democratic Republic of Congo, Nigeria*
Greater cane rat	*Thryonomys swinderianus*	*28*	*8*	*30.48*	*not listed*	*Cameroon, Ivory Coast, Nigeria, Togo*
Red river hog	*Potamochoerus porcus****	*14*	*2*	*4.78*	*not listed*	*Cameroon, unknown African country*
Gaboon viper	*Bitis gabonica*	*2*	*1*	*4.10*	*not listed*	*Cameroon*
Red-flanked duiker	*Cephalophus rufilatus*	*8*	*1*	*3.91*	*not listed*	*Cameroon*
Insects	*CLASS Insecta* † (2-3 species)	*3*	*2*	*3.76*	*unknown species/listing*	*Cameroon*
Giant African land snail	*Achatina or Archachatina* spp. †	*5*	*3*	*2.70*	*not listed*	*Ivory Coast, Cameroon*
Mallard duck	*Anas platyrhynchos*	*1*	*1*	*2.40*	*not listed*	*Israel (via China)*
Common duiker	*Sylvicapra grimmia*	*2*	*1*	*2.35*	*not listed*	*Democratic Republic of Congo*
African palm civet	*Nandinia binotata*	*1*	*1*	*2.06*	*not listed*	*Cameroon*
Walter's duiker	*Philantomba walteri*	*1*	*1*	*1.80*	*not evaluated - new species*	*Nigeria*
Maxwell's duiker	*Philantomba maxwelli*	*5*	*1*	*1.31*	*not listed*	*Cameroon*
Sitatunga	*Tragelaphus spekii*	*1*	*1*	*1.00*	*not listed*	*Kenya*
Crocodile	*FAMILY Crocodylidae* †	*1*	*1*	*1.00*	*unknown species/listing*	*South Africa*
Cave swift	*Aerodramus* spp. †	*1*	*1*	*0.63*	*not listed*	*Singapore*
Peter's duiker	*Cephalophus callipygus*	*1*	*1*	*0.49*	*not listed*	*Cameroon*
TOTALS		***179***		***204.16***		

** Manis* spp. originated in Africa where 3 species are present, although evaluation of photo evidence makes it likely that all Manis spp. in this study were African Tree Pangolins (*Manis tetradactyla*). Eight *Manis* carcasses were identified based on DNA results for an identical carcass within the confiscation.

***Cercopithecus* spp. were identified only to the genus level because of underrepresentation in the DNA databank, and include from 1 to 3 species, based on their presence in 3 separate confiscations.

*** Eight *Atherurus africanus* carcasses were identified based on DNA results for an identical carcass within a confiscation. *Atherurus africanus* also contains 5 samples (1.41 kilograms) which were identified only to the genus level in DNA analysis (as *Atherurus* spp.); because the confiscation containing these samples came from Africa, and there is only one *Atherurus* species present there, we included these kilograms in *Atherurus africanus.* However, samples did not match with either *Atherurus africanus* or *Hystrix cristata*, the 2 species of porcupines from this region that are present in the online genetic databank.

*****Potamochoerus porcus* contains 4 samples (0.93 kilograms) which were visually identified based on pelt similarity to other pieces in the confiscation that were identified with DNA analysis.

† Identification was determined morphologically; DNA was not analyzed for this identification.

TABLE 16: Domestic and fish species found during the study, including the countries where the meat originated. Countries of origin are listed from the country which had the highest amount of meat (in kilograms) to the country with the lowest amount of meat found during the study.

COMMON NAME	***SPECIES***	***Number of samples***	***Number of confiscations***	***Weight in kilograms***	***Countries of Origin of Meats (listed from highest to lowest kg)***
DOMESTIC SPECIES					
Cow	*Bos taurus* *	35	18	37.46	*Kosovo, Cameroon, Kenya, Ivory Coast, Senegal, Thailand, Brazil, Nigeria, Singapore, South Africa, Canada*
Pig	*Sus scrofa*	16	8	16.57	*Korea, Egypt, Togo, Ukraine, Singapore, China, Kosovo*
Chicken	*Gallus gallus*	9	5	4.34	*Cameroon, Egypt, Thailand, Singapore, China*
Water Buffalo	*Bubalus bubalis*	2	2	4.24	*Turkey, Morocco*
Turkey	*Meleagris gallopavo*	2	1	2.67	*Turkey*
Donkey	*Equus asinus*	2	1	1.88	*Nigeria*
Goat	*Capra hircus*	2	2	1.16	*Turkey, Cameroon*
FISH SPECIES					
African catfish	*Clarias pachynema*	2	1	2.40	*Nigeria*
Shrimp	*FAMILY Penaeidae* † (1-2 species)	3	2	1.47	*Nigeria, Brazil*
African sharp-tooth catfish	*Clarias gariepinus*	1	1	1.20	*Ethiopia*
Whipray	*Himantura* spp.	1	1	0.48	*Singapore*
Nordic fish	*Brosme brosme*	1	1	0.20	*Nigeria*
Nordic fish	*Molva molva*	1	1	0.15	*Nigeria*
UNIDENTIFIED SPECIES					
Unidentified meat pieces	*unidentified species*	24	17	17.79	*Russia, Turkey, China, Korea, Egypt, Kosovo, Nigeria, Thailand, Qatar, Singapore, Cameroon, Brazil*
TOTAL		***101***		***92.01***	

**Bos taurus* includes 3 samples (1.73 kg) which were identified in DNA analyses as either *Bos taurus* or *Bos indicus*; *Bos indicus* is a species of domesticated cattle originating in Africa, and the ambiguous samples originated from confiscations arriving from Senegal and Thailand.

† Identification was determined morphologically; DNA was not analyzed for this identification.

RESULTS:
How Much Bushmeat is coming into Switzerland?

VI. A Model for Determining an Annual Amount of Bushmeat into Switzerland

Components of the Model

Several components were used to create a model that would estimate the amount of bushmeat smuggled into Switzerland. Most data for the model was collected during control day searches of targeted planes. The number of passengers searched and the number and weight of meat confiscations from the searched passengers was recorded. DNA or visual species identifications gave us the proportion of the smuggled meats that were bushmeat. The total number of passengers moving through the airport during the search hours was obtained from airport statistics to estimate overall volumes. The model methodology is described in detail in this section.

1.) Targeted Flights; Control Day Searches for Bushmeat

A number of flights were targeted for searches on 5 control days. These flights were chosen beforehand, based on internal criteria for searches in each of the airports. From these targeted flights, we collected data on the total number of passengers on each flight, the number of passengers searched, and the number of passengers carrying meat and/or bushmeat.

In some cases, passengers picked for a search were discovered to be from flights other than those targeted; in cases where a confiscation occurred from these flights, the flight was added to our control day database of flights searched. Only those flights targeted by customs, or those flights added to the targeted list during the control day (once all targeted flights were searched), were considered for our analysis of search effort (n=67 flights). Information on the total number of people on a given flight was collected for 85% of the targeted flights (n=57). For some flights (n=14), the total number of passengers was not known; in these cases, the type of plane flown by that airline for that flight was obtained from online references, and flights were estimated to be at 70% capacity (in regard to total passengers). While the search area was sometimes quite busy, we counted the number of passengers that were controlled (i.e. searched) from targeted flights; however, for the first two control days, only the total number of passengers searched was available. For the last three control days, information on number of passengers searched from each targeted plane was collected.

2.) Search Effort: The Proportion of Targeted Passengers and Total Passengers Searched

The volume of passengers moving through the airports daily, coupled with present staffing levels for customs agents, and the responsibility of a myriad of contraband items to search for, means that customs agents are able to search only a small fraction of passengers arriving in Switzerland. Zürich Flughafen targeted 32 flights on 2 control days and approximately **3.5 - 5.3%** of the passengers from these targeted flights were searched. Genève Aéroport targeted 35 flights on 3 control days and approximately **6.7 - 13.5%** of these passengers were searched. When considering the two airports together, in regard to control days, Swiss customs agents were able to search an average of **7.4% (3.5-13.5%)** of the passengers arriving on the flights targeted for searches. Results are shown in **TABLE 17**.

Online airport statistics from Zürich (Zürich Flughafen 2012) and Geneva (Genève Aéroport 2012) provided the ***total number of passengers*** moving through each airport. In 2012, there were a total of *24,761,989 passengers* moving through Flughafen Zürich and a total of *13,899,422 passengers* moving through Genève Aéroport (Flughafen Zürich 2012; Genève Aéroport 2012). In comparison, Flughafen Zürich passenger volume is approximately double that of Genève Aéroport. In the Zürich Flughafen statistics, the annual number of passengers included arriving, departing and transit passengers, of which expert opinion estimated 1/3 to be *arriving passengers* (*Swiss Customs Administration, pers. comm.*).

Genève Aéroport statistics noted that transit passengers were removed, so that the total number of passengers was divided by 2 to obtain arriving passengers. From this annual number of passengers, we estimated the ***total number of passengers arriving per search hour***, based on a 365 day year/24 hour day.

From this estimated number of passengers arriving during control day search hours, we determined that targeted flights contained approximately **20%** of the total passenger volume moving through the airport. Results showed that **1.0 - 1.7%** of the *total arriving passengers* into Zürich Flughafen were searched on control days, and in Genève Aéroport, **1.5 - 2.7%** of the *total arriving passengers* were searched. When considering the two airports together, the proportion of the total arriving passengers that were able to be searched upon arrival in Switzerland was on average **1.8%** (**1.0 - 2.7%**) of the total arriving passengers. Results for search effort can be viewed in **TABLE 17**.

3.) Proportion of Confiscated Meats Identified as Bushmeat on Control Days

Another important question is how much of the confiscated meat arriving in Switzerland is bushmeat? We looked at results from our control day searches to determine the proportion of confiscated meats that were identified as bushmeat, which was quite high, and although it must be noted that sample sizes for control days were small, the results were consistent. For the 3 control days in Geneva, on average 1 to 2 out of 3 passengers, or **33.3 - 66.7%** (average = **44%**) from whom meat items were confiscated, proved to be carrying some type of wild meat. In Zürich, the number of passengers from which items were confiscated was larger; 12 confiscations of meat occurred on each control day, of which 1 item per day was identified as originating from a wild species, so that on average **8.3%** of the Zürich meat confiscations were bushmeat or wild meat. When considering the two airports together, an average of **18%** (**8.3 - 66.7%**) of the total meat confiscations in Switzerland, and **20%** (**2.5 – 56.7%**) of the total kilograms of meat collected, were identified as bushmeat or wild meat on the control days. These results can be seen in **TABLE 17**.

4.) The Proportion of Meats Recognized as Bushmeat in Swiss Customs Records

Because the sample size on control days was relatively small, we also examined the Customs confiscation records for 2008 through 2012 to determine the proportion of the total meat confiscations in Swiss Customs record data that were described as bushmeat or wild meat. When considering the two airports separately, there is a marked difference in the amount of overall confiscations that are described as bushmeat or wild meat for Zürich Flughafen *vs.* Genève Aéroport. Geneva tends to have a higher proportion of overall meat confiscations and kilograms that are recognized as wild meats. In 2012, the period when this study was in progress, **6%** of meat confiscations and **10%** of the total meat kilograms in Geneva were described as bushmeat or some type of wild meat, while only **1%** of meat confiscations and **3%** of the total kilograms of meat confiscated in Zürich were described thus. When the data is combined to reflect all of Switzerland for 2012, results show that **2%** of meat confiscations and **4%** of meat kilograms were described by Customs agents as some type of bushmeat or wild meat. Results of this exercise are presented in **FIGURE 23** and **FIGURE 24**.

5.) Proportion of Searched Passengers Smuggling Bushmeat

For our model, we determined *the proportion of the searched passengers that were smuggling meat or bushmeat confiscations* on control days. An average of **13%** of the passengers searched at Zürich Flughafen, and **2.4%** of the passengers searched at Genève Aéroport, were smuggling some type of meat. When the two airports were combined, an average of **5.9%** of the total passengers searched on arrival in Switzerland were smuggling some type of meat.

When considering only those meat confiscations from control days that were identified as some type of bushmeat or wild meat product, results were very similar for the two airports; on average, **1.1%** (range = **0.8 – 1.8%**) of the passengers searched upon arrival in Switzerland on our control days were carrying bushmeat. These results can be seen in **TABLE 17**.

6.) Bushmeat Smuggling Regions: Estimating a Number of Smugglers per Region

When considering passengers arriving in Swiss airports daily, it is of course true that not all passengers are equally likely to be smuggling meats. For example, we have already shown that passengers arriving from African regions are more likely to be carrying bushmeat than passengers from any other region (see **FIGURES 2** and **3**). Therefore, the calculations in our model included only those countries or regions which were found to have smuggled bushmeat in 2012 and *all non-bushmeat smuggling countries or regions were not included in the model presented in this report*. This is quite conservative, especially as an examination of the Customs confiscation records from 2008-2011 includes a number of bushmeat smuggling countries that were not included in our present model. Our model is also very conservative in that it weights the total number of passengers in each smuggling region by multiplying the *total number of annual passengers* arriving from each bushmeat smuggling region in 2012 by the *proportion of confiscations that were found to be bushmeat* from that region. For example, if 1% of total bushmeat came on Asian flights, then only 1% of the total passengers arriving from Asia were considered as potential smugglers. While this is a very rough method of estimation, we considered this *weighted number of passengers* as representing the number of passengers from each region that had the *potential* to be smuggling bushmeat.

To estimate a number of smugglers for each region, the *number of potential smugglers* from each region was multiplied by the proportion of searched passengers found to be carrying bushmeat from our control days (this was determined to be *an average of **1.1%** of the total arriving passengers* - see **TABLE 17**). Again, this is very conservative, as Swiss Customs Records for 2012 describe ***1.8%*** of meat confiscations in 2012 to be bushmeat or wild meat (see **FIGURE 23**). It is especially conservative when considering a region such as Africa, for which on average, **15%** of confiscations were described as bushmeat or wild meat in the Swiss Customs Records for 2012 (see **FIGURE 2**). This calculation resulted in an *estimated number of smugglers* for each region, which is shown in **TABLE 18**.

7.) Amount of Bushmeat Smugglers Carry; The Average Size of Bushmeat Confiscations in 2012

It has already been noted that not all wild meat confiscations arriving in the airports in 2012 were sampled; bushmeat confiscations in this study were only a subset of the total bushmeat confiscations coming into Swiss Airports in 2012 (see page 26; 44.4% of Zürich Flughafen confiscations and 15% of Genève Aéroport confiscations described by Customs Agents as bushmeat or some type of wild meat in the 2012 Customs Record Data were sampled for this study). During our study, we collected samples from approximately 200 kg of bushmeat. According to Swiss Customs, the total amount of bushmeat confiscated in the Swiss Customs Records for 2012 was closer to 400 kilograms (381 kg; EFD/EZV 2013). To determine the average size of bushmeat confiscations, we therefore combined the data collected during the study with the record data provided by Customs in order to include all bushmeat confiscations from 2012 (confiscations from our study sampled in 2011 or 2013 were not included). Using this combined data, the average size of all known bushmeat confiscations in 2012 was determined to be **6.4 kg** ± **1.1 kg**.

8.) Bushmeat Amounts by Smuggling Regions

Each region from which wild meat smuggling occurred was included in the model presented in this report. The *estimated number of smugglers* for each smuggling region was multiplied by the *average*

amount of bushmeat carried by passengers in 2012 to estimate an amount of meat (in kg) arriving from each smuggling region. These amounts were then summed to determine the amount of bushmeat smuggled into Switzerland in 2012. Results of the model can be viewed in **TABLE 18**.

Limitations and Biases within the Model

In any model or estimation, there are a number of uncertainties, biases, and assumptions; these are discussed below for the model presented in this report. Because of this, we consider the model presented here as a preliminary estimate only - a more sophisticated model, addressing some of the issues listed here, is currently in progress and will be presented at a later date.

The planes targeted on control days may have been more or less likely to carry bushmeat; In Zürich, control day foci included a diversity of wildlife products of concern (i.e. Chinese medicines, illegal plants such as *Orchidae*, caviar, and bushmeat). Because of this, a number of targeted flights (38%) were of *Asian*, *Russian*, or *Eastern European* origin. However, according to results from this study, *only 1% of bushmeat arriving in Switzerland comes from regions outside Africa*. Of the targeted flights on Zürich control days, only 25% had *known* African connections. In contrast, the three control days at Geneva included a more specific focus on bushmeat (and caviar), with the majority of targeted flights having *known* connections to Africa (80%), and the remainder Russian and Eastern European flights (6%). As a result, the likelihood of finding bushmeat on Zürich control days may have been lower.

Not all regions/passengers arriving in Switzerland are equally likely to be smuggling bushmeat: We decided which regions to include in the model by using only those that smuggled bushmeat into Switzerland in 2012, and we included numbers of arriving passengers from these regions only. Regions known to have smuggled wild meat in the Swiss Customs Records for 2008-2011 were not included in the model, as they did not smuggle bushmeat in 2012. Determining which regions/passengers to include in the model was complicated by the fact that *while the majority of bushmeat originates in African countries, it arrives in Switzerland on transit flights from within Europe*. Because of this, we created two separate models (a Meat Origin model and a Flight Origin model). For the Flight Origin model, European passengers were included, but only those passengers arriving from European countries which carried bushmeat into Switzerland. This left a large number of passengers from many European countries out of the model, even though bushmeat is known to have been confiscated in the airports of these countries, and some have smuggled bushmeat into Switzerland in other years.

The number of passengers from a given smuggling region were weighted by the amount of bushmeat from each region to estimate some number of passengers with the potential to be smugglers: We weighted arriving passengers by the proportion of bushmeat arriving from their region – however, we consider this a very crude method of estimation. A more correct method is currently in progress in a more sophisticated model that will incorporate information in regard to the proportion of passengers arriving in Switzerland on flights from the various regions.

Differences between the two airport's flight profiles by region were not fully known as it was not a focus of this study: Differences in the proportion of overall meats recognized as bushmeat in Zürich Flughafen *vs.* Genève Aéroport may also reflect differences in the overall proportions of flights arriving into these airports from the various regions, which would affect the model. For example, there may be proportionally more flights of African origin, or more flights with connections to Africa arriving in Geneva, while Zürich may have a higher proportion of flights from Asian and Eastern European countries. There is some evidence of this, in that Zürich does have a number of direct Asian flights that are not present in Geneva, and also has flights from Eastern European countries that are not present in

Geneva. Customs records for meat confiscations in 2012 show that *while the amount of confiscations and kilograms of bushmeat from Africa is similar for the two airports*, results for Zürich are offset by a large amount of meat confiscated from Asian and Eastern European countries. For example, in the Customs record data for Zürich, over *50% of the meats confiscated at Zürich Flughafen in 2012 were wursts and/or other processed meats arriving from Eastern European countries*. In order to more accurately estimate the proportion of the total confiscated meats that are bushmeat, it would be necessary to have a more detailed profile of the proportions of overall flights, passengers, and meats arriving from each region.

Sample size for control days was small and some data points were missing or not included in the model: The sample size for meat confiscations on control days was small and therefore the model would be strengthened by a larger sample size of targeted planes and meat vs. bushmeat confiscations. Because of the small sample size, Customs Record data was used to augment control day results. However, there were several bushmeat confiscations in the 2012 records for which meat origin was not known (1.8% of confiscations) or flight origin was not known (9.1%) and these confiscations were therefore not included in the model. Their inclusion would likely have impacted the estimate, especially in the case of the Flight Origin model.

Cryptic bushmeat (i.e. pieces and cuts not recognized as bushmeat by customs agents) are not taken into account: The number of bushmeat confiscations and amounts in this study is based *only on those confiscations recognized or suspected by customs of being bushmeat*. This does not include bushmeat that was not found, but instead entered Switzerland. It is also highly likely that during 2012, some wild meats were not recognized, or not recorded in the Customs records, as bushmeat. Our study provides evidence of this. Some of the meats sampled during the study were identified in the DNA analysis as bushmeat, but during the Customs searches, were not recognized as bushmeat, and were entered in their records with a generic 'meat' descriptor. During this study, 17% of the total confiscations we tested and found to be bushmeat or wild meat were entered in the Customs records with a description that did not identify it as a wild meat, but rather gave it a generic 'meat' description, or identified it as some type of domestic or farmed animal meat. Because of this, the total amount of bushmeat used in the model is very likely to be an underestimation of the true amount.

Results are derived from data for Zürich and Geneva airports only*:* The model does not include passengers from other Swiss airports which also have international flights. It also does not include other means of entry, such as trains, cargo containers, and road traffic, all of which are known forms of entry into Switzerland (Läubli 2010; Fuss 2012; SDA 2014). A recent seizure by Customs in Basel Switzerland provides evidence of bushmeat smuggling over roads via other airports; 16 kg of bushmeat from Cameroon was being smuggled from St. Louis, France to Basel, Switzerland in the trunk of a car when it was seized by Customs, including crocodile, python and CITES-listed pangolins; the bushmeat was likely to have arrived at the nearby EuroAirport (Basel-Mulhouse-Freiburg) in Saint-Louis, France (SDA 2014). Confiscations from all points of entry would need to be included in order to estimate the true amount of bushmeat coming into Switzerland, and indicate that the model presented here is most likely to be an underestimation of the actual amount coming in.

Model Summary and Results

The current model was based on results of this study and Customs records of bushmeat confiscations in 2012. The model calculations were as follows;

$$BM_{est} = \left\{ \sum_{i=0}^{n} \left((Npass_i \cdot bmp_i) \cdot (Smugg_{bm}) \right) \cdot \left(BM_{avg} \right) \right\}$$

Where $Npass_i$ is the *total number of arriving passengers* from each bushmeat smuggling region (regions *i* through *n*) and where bmp_i is the proportion of meat confiscations that were identified as bushmeat for each smuggling region. These were multiplied in order to weight the total number of arriving passengers from a given smuggling region as we considered not all passengers from a region to be equally likely to smuggle bushmeat. This calculation gives us a number of potential smugglers for each smuggling region. These potential smugglers were then multiplied by a constant ($Smugg_{bm}$) which is the proportion of passengers from our control days who were searched and found to be carrying bushmeat (1.1%). This calculation estimated a number of bushmeat smugglers for each smuggling region. The estimated number of bushmeat smugglers for each region was then multiplied by another constant (BM_{avg}) or the average size of bushmeat confiscations in 2012 as determined from this study combined with 2012 Customs record data (6.4 ± 1.1 kg), giving us an estimated amount of bushmeat (in kg) for each smuggling region. These amounts were then converted to tonnes[5] and summed to give us an estimated amount of bushmeat (in tonnes) for all of Switzerland.

Model of Meat Origin vs. Flight Origin

While the majority of bushmeat in 2012 came from African countries, most arrived on flights originating from within Europe (see **FIGURE 5**). In order to take into account the fact that bushmeat coming into Switzerland is more likely to arrive on a flight from within Europe than on a flight from which the meat originated, we created two different models; a ***Meat Origin Model*** *vs.* a ***Flight Origin Model***. These models differed as follows; our **Meat Origin Model** used the total numbers of arriving passengers from the *regions of origin of the smuggled bushmeat*, and our **Flight Origin Model** used the total number of arriving passengers from the *regions of origin of departing flights which carried bushmeat into Switzerland*. The standard error of the average size of bushmeat confiscations and the differences between models were used to describe confidence intervals.

The current models suggest an amount approximating at least ***40 tonnes of bushmeat*** was smuggled into Switzerland in 2012. We considered the meat origin model, which included only those regions *outside of Europe* which were found to have smuggled bushmeat in 2012, as our base model, as it includes no passengers arriving from within Europe. This model estimated that ***37.5 tonnes ± 6.3 tonnes of bushmeat*** arrived in Switzerland in 2012. However, because the majority of bushmeat confiscations in this study were found to arrive on flights within Europe, we created our flight origin model, which included only passengers from those European countries from which flights departed carrying bushmeat into Switzerland. This model estimated that ***41.9 tonnes ± 7.0 tonnes of bushmeat*** were smuggled into Switzerland in 2012. Summary results of the models are presented in **TABLE 18**.

In the models presented in this report, we used a figure from our control days (i.e. *the overall proportion of the searched passengers that were carrying bushmeat confiscations* = **1.1%**) to estimate the number

[5] The *tonne* is a metric system unit of mass equal to 1000 kilograms (2,204.6 pounds). In the United States, it is known as a *metric ton*.

of bushmeat smugglers. However, we also considered what would happen if the proportion of passengers carrying bushmeat was higher. Our examination of the Customs records of confiscations for 2012 showed that **1.8%** of all meats confiscated in 2012 were described by customs agents as some type of bushmeat or wild meat. We addressed this possibility by using 1.8% in the model as the proportion of passengers smuggling bushmeat (instead of the 1.1% of searched passengers carrying bushmeat from our control day data). When this higher proportion is used, the estimate increased to approximately ***60*** *to* ***80 tonnes*** of bushmeat annually (Meat Origin Model = ***63.56 tonnes ± 10.65 tonnes***, Flight Origin Model = ***71.01 tonnes ± 11.90 tonnes***). While results for the meat and flight origin models presented here are similar, it must be noted that in our flight origin model, we considered only passengers from those European regions which smuggled bushmeat into Switzerland in 2012. Because a substantial portion of bushmeat found during this study (60%) of bushmeat came on flights from within Europe, and because it is likely that bushmeat could arrive from European regions that were not included in the model, we also created a model that considered *all European passengers* as having the potential to smuggle bushmeat. While these results are not presented here, when all European regions/passengers are included in the model, results show *an order of magnitude difference*.

Our current estimate of 40 tonnes is larger than a previous risk estimate by Vetsuisse presented in Falk et al (2013) of ***8.6 tonnes*** of bushmeat per year for Switzerland. The Falk et al estimate, however, was based on Swiss Customs records of confiscations *from 2008 through September of 2011* and the records for two of these years (2008 and 2011) were incomplete; data entry into Excel spreadsheets did not begin until May 2008 in Genève Aéroport and August 2008 in Zürich Flughafen. The records for 2011 were also obtained before the year 2011 ended, and were complete only through September 2011 in Zürich and October 2011 in Geneva. Also of note is that the amount of bushmeat recorded in Zürich in 2010 was very low; the reason for this is not known, but may reflect a focus on other contraband items/regions by customs agents. While the Falk et al estimate did take into account the skewed distribution of meat kilograms (this distribution can be viewed in **FIGURE 17**), it did not take into account the more recent findings from this study - that bushmeat confiscations are significantly larger than other types of meat confiscations. Finally, Falk's estimate also did not take into account that the amount of bushmeat is increasing each year (see next section, **FIGURE 25** and **FIGURE 26**). It is relevant to our estimate that *the amount of bushmeat found in 2012 is higher than in all other previous years* (see next section); our current estimate is based only on results of bushmeat amounts smuggled in 2012. Confidence intervals around the Falk et al estimate do show that anywhere from ***0.5*** **to** ***88.5 tonnes*** of bushmeat per year are possible in their model.

A More Sophisticated Model of the Amount of Bushmeat Smuggled into Switzerland is in Progress

While the model presented in this report is preliminary, it represents an interesting exercise in possibilities and so was included in this report. However, as were concerned with the limitations of the model, we joined into collaboration with statisticians in the bioinformatics department at the University of Bern and a more sophisticated and statistically robust version of our model is currently in progress. Results from this new model will be presented at a later date, but will include bootstrapping for confidence intervals as well as a more sophisticated methodology for estimating the number of smugglers (*Hauser, unpublished data*). The crude method used in this model (of removing passengers from a given region by weighting them by the proportion of bushmeat from that region, and not including some regions at all, is likely to have grossly underestimated the number of smugglers. As a result, the estimate presented here is very conservative. Preliminary results from the more statistically sophisticated model already suggest that the amount of bushmeat being smuggled into Switzerland may be much higher than the 40 tonnes presented here.

FIGURE 23: The Proportion of the Total Meat Confiscations and Kilograms in Swiss Airports Recognized as Bushmeat; The proportion of the ***total meat confiscations and kilograms*** that were described by Swiss Customs agents as bushmeat or wild meat in the combined Customs records for 2008-2012.

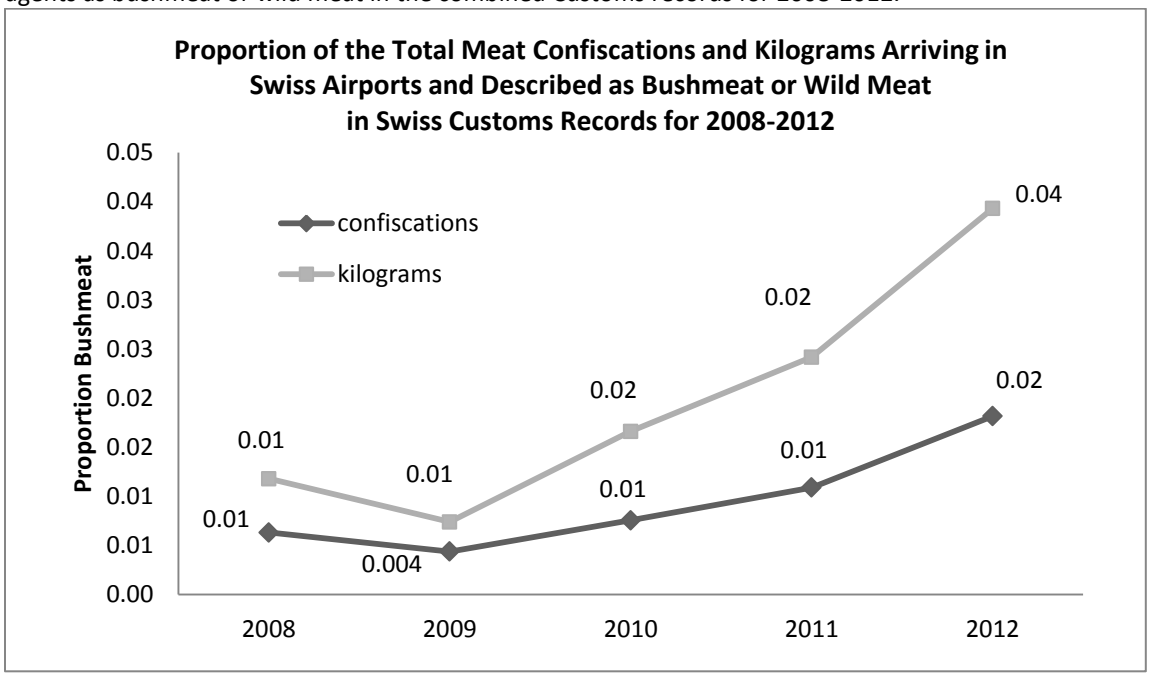


FIGURE 24: Differences in Bushmeat Proportions at Swiss Airports; the proportion of the ***total meat confiscations and kilograms*** that were described by Swiss Customs agents as bushmeat or wild meat in the Customs records in 2008-2012 for Flughafen Zürich vs. Genève Aéroport. Geneva typically has a higher proportion of the total meat confiscations that are described as bushmeat. However, the total amount of bushmeat (in kilograms) coming into each airport is similar.

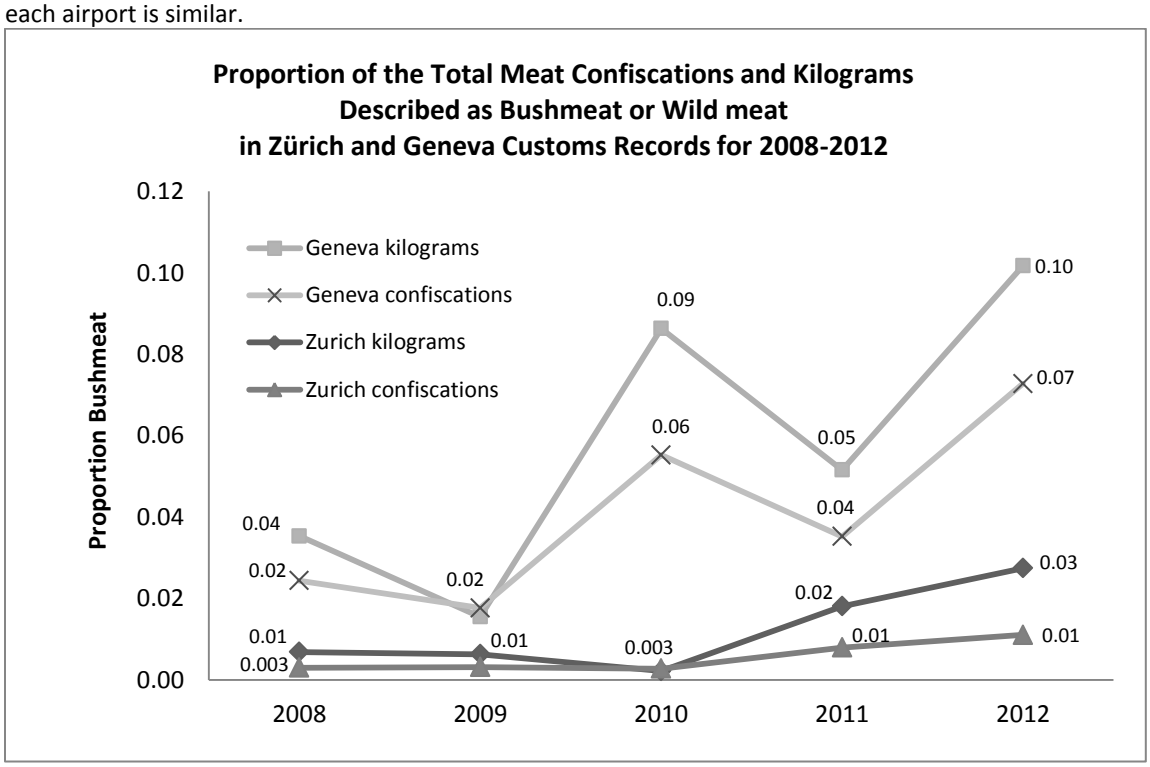


TABLE 17: Summary of Control Days at Zürich Flughafen and Genève Aéroport: the table includes number of targeted flights, search effort for targeted flights and overall airport passenger volumes, and the amounts and proportion of illegal meat confiscations identified as bushmeat for the 5 control days in this study.

Control Day	**A.** Number of targeted planes	**B.** Total number of passengers on targeted planes	**C.** Total number of passengers from targeted planes that were searched	Proportion of targeted passengers searched (=C/B)	**D.** Number of search hours	**E.** Number of people arriving per hour (derived from 2012 airport stats)	**F.** Number of people arriving in airport during control day hours (=D*E)	Proportion of total arriving passengers on targeted planes (=B/F)	Proportion of total arriving passengers searched (=C/F)	**G.** Total number of searched passengers with meat confiscations	Proportion of searched passengers with meat confiscations (=G/C)	**H.** Total number of searched passengers with bushmeat confiscations	Proportion of searched passengers with bushmeat confiscations (=H/C)	Proportion of meat smugglers that were smuggling meats identified as bushmeat (=H/G)	**I.** Total amount of meat (in kg)	**J.** Total amount of bushmeat (in kg)	Proportion of confiscated meat kilograms that were bushmeat (=J/I)	**K.** Total number of samples collected	**L.** Total number of samples identified as bushmeat	Proportion of total samples identified as bushmeat (=L/K)
ZÜRICH																				
Control Day 1 – Zürich 29-Sep-11	18	2,392	127	**5.31%**	8	925.3	7,402.5	**32.31%**	**1.72%**	12	**9.45%**	1	**0.79%**	**8.33%**	25.7	0.63	**2.45%**	34	1	**2.94%**
Control Day 2 – Zürich 20-Dec-12	14	1,612	57	**3.54%**	6	925.3	5,551.9	**29.04%**	**1.03%**	12	**21.05%**	1	**1.75%**	**8.33%**	24.49	1.0	**4.08%**	26	1	**3.85%**
GENEVA																				
Control Day 1 – Geneva 13-Oct-11	14	1,186	149	**12.56%**	7	793.4	5,553.4	**21.36%**	**2.68%**	3	**2.01%**	1	**0.67%**	**33.33%**	4.3	1.0	**23.26%**	8	3	**37.50%**
Control Day 2 – Geneva 23-Dec-11	10	1,396	93	**6.66%**	8	793.4	6,346.8	**22.00%**	**1.47%**	3	**3.23%**	1	**1.08%**	**33.33%**	11.1	6.29	**56.67%**	16	11	**68.75%**
Control Day 3 – Geneva 4-Oct-12	11	984	133	**13.52%**	7	793.4	5,553.4	**17.72%**	**2.39%**	3	**2.26%**	2	**1.50%**	**66.67%**	13.2	6.9	**52.27%**	10	6	**60.00%**
TOTALS																				
Zürich Subtotal	32	4,004	184	4.60%	14	1,850.6	12,954.4	30.91%	1.42%	24	13.04%	2	1.09%	8.33%	50.19	1.63	3.25%	60	2	3.33%
Geneva Subtotal	35	3,566	375	10.52%	22	2,380.1	17,453.6	20.43%	2.15%	9	2.40%	4	1.07%	44.44%	28.6	14.2	49.62%	34	20	58.82%
TOTAL (Switzerland)	**67**	**7,570**	**559**	**7.38%**	**36**	**4,230.7**	**30,408.0**	**24.89%**	**1.84%**	**33**	**5.90%**	**6**	**1.07%**	**18.18%**	**78.79**	**15.82**	**20.08%**	**94**	**22**	**23.40%**
AVERAGE (Switzerland)	**13.4**	**1,514.0**	**111.8**	**-**	**7.2**	**846.1**	**6,081.6**	**-**	**-**	**6.6**	**-**	**1.2**	**-**	**-**	**15.76**	**3.16**	**-**	**18.80**	**4.40**	**-**

TABLE 18: The two Models for determining how much bushmeat may be arriving in Switzerland annually; MODEL 1 uses the region of origin of the meat to estimate total kilograms of bushmeat, and **MODEL 2** uses the departure point of flights carrying bushmeat into Switzerland. **G.)** ***the proportion of searched passengers smuggling bushmeat*** was determined from our control days to be **1.1%**, and **I.)** ***the average size of bushmeat confiscations*** in 2012 was determined from all bushmeat confiscations recorded in this study, combined with Swiss Customs Records during 2012, to be **6.4 kg ± 1.1 kg**.

MODEL 1: REGION OF ORIGIN OF THE BUSHMEAT	A. Number of Bushmeat Confiscations in 2012	B. TOTAL number of passengers in 2012	C. Number of Arriving Passengers in 2012	D. Proportion of overall bushmeat confiscations from region	E. Potential Smugglers (A * D)	F. Estimated number of smugglers (E * G†)	H. Estimated kilograms of smuggled bushmeat (F * I††)	J. Estimated smuggled bushmeat (in tonnes)
Africa	46	1,139,344	446,332	85.19%	380,208.9	4,068.2	26,004.0	26.0
Asia (Far East and Middle East)	6	3,263,003	1,187,552	11.11%	131,950.2	1,411.9	9,024.6	9.0
Americas (North, Central and South)	2	2,669,846	960,789	3.70%	35,584.8	380.8	2,433.8	2.4
Unknown origin	1	-	-	-	-	-	-	-
Grand Total	**55**	**7,072,193**	**2,594,673.5**	**1.0**	**547,743.9**	**5,860.9**	**37,462.4**	**37.5**

MODEL 2: REGION OF ORIGIN OF THE FLIGHT CARRYING BUSHMEAT INTO SWITZERLAND (Departure point of bushmeat flights)	A. Number of Bushmeat Confiscations in 2012	B. TOTAL number of passengers in 2012	C. Number of Arriving Passengers in 2012	D. Proportion of overall bushmeat confiscations from region	E. Potential Smugglers (A * D)	F. Estimated number of smugglers (E * G†)	H. Estimated kilograms of smuggled bushmeat (F * I††)	J. Estimated smuggled bushmeat (in tonnes)
Africa	6	1,139,344	446,332.2	12.00%	53,559.9	573.1	3,663.2	3.7
Far East	2	1,554,615	518,205.0	4.00%	20,728.2	221.8	1,417.7	1.4
Middle East	5	1,909,056	769,681.0	10.00%	76,968.1	823.6	5,264.2	5.3
USA	1	2,466,718	893,080.0	2.00%	17,861.6	191.1	1,221.6	1.2
Belgium	22	781,951	345,605.2	44.00%	152,066.3	1,627.1	10,400.4	10.4
England	1	5,009,508	2,157,404.5	2.00%	43,148.1	461.7	2,951.1	3.0
France	8	2,948,085	1,269,424.8	16.00%	203,108.0	2,173.3	13,891.4	13.9
Netherlands	1	1,295,343	451,618.5	2.00%	9,032.4	96.6	617.8	0.6
Switzerland	3	1,111,143	491,484.5	6.00%	29,489.1	315.5	2,016.9	2.0
Denmark	1	633,196	297,826.7	2.00%	5,956.5	63.7	407.4	0.4
Unknown origin	5	-	-	-	-	-	-	-
Grand Total	**55**	**18,848,959**	**7,640,662.3**	**1.0**	**611,918.1**	**6,547.5**	**41,851.5**	**41.9**

† **G =** the proportion of searched passengers smuggling bushmeat (as determined from control days) **= 1.1%**

†† **I =** the average size of bushmeat confiscations from all confiscations of wild meat/bushmeat collected in 2012 (this study and Customs Records) **= 6.4 ± 1.1 kg**

RESULTS:
Rate of Increase
for Bushmeat in Switzerland

VII. Rate of Increase – Is More Bushmeat Coming?

Number/Kilograms of Bushmeat Confiscations in the Airport Confiscation Databases

We examined the Customs records for the Zürich and Geneva Airports from 2008 through 2012 to determine a rate of increase for the weight of all confiscations (in kg) that were described by Customs agents as some type of bushmeat or wild meat.

It is interesting that while the amount of overall meat confiscations arriving in Zürich is roughly *10 times* that of Geneva, the amount of bushmeat (in kg) that comes into these two airports each year is similar. This result is presented in **FIGURE 25**. However, differences between the two airports show that, in regard to the total amount of meat confiscated, the proportion described by Customs agents as bushmeat is higher in Geneva than in Zürich (see **FIGURE 23** and **FIGURE 24**). The reason for this difference is unknown, but a number of explanations exist. It may be that, as passenger volume is lower in Geneva, more passengers can be effectively searched, or that Geneva customs may target bushmeat smugglers more effectively than Zürich. Conversely, lower amounts of bushmeat in Zürich may reflect the larger proportion of processed meats from non-bushmeat smuggling regions (see pages 68-69), or a focus on other regions/contraband items. There appear to be fewer bushmeat confiscations in 2008-2009 for Geneva, and fewer in Zürich in 2010, with steady increases thereafter. Reasons for these low amounts may include a number of factors; the year 2008 represents an incomplete dataset, as it was the start of confiscations being recorded in an excel database (data entry began in May 2008 in Geneva and in August 2008 in Zürich). The decreases from 2009 to 2010 in Zürich and from 2010 to 2011 in Geneva may reflect a focus on other regions/contraband items. Likewise, increases may indicate that Customs officers were more focused on bushmeat or were beginning to recognize and note bushmeat more effectively in their records. The increases in 2012 may also reflect an increase in search effort because of this study, so that more of the bushmeat being smuggled through the airports was actually found and seized rather than escaping into Switzerland undetected.

Regardless of the differences between the two airports, when the data from these airports is combined, it is clear that there has been a steady increase in the number of recognized bushmeat/wild meat confiscations coming into Switzerland during this 5 year period. The increase from 2011 to 2012 is particularly marked. It is not known if this effect is due to an increase in search effort because of this study, or if the trend in fact indicates a true increase in the amount of bushmeat coming in. However, the overall trend for both airports is positive and when the data are considered together, an exponential trend line is the best fit ($R^2 = 0.9821$); this trend is illustrated in **FIGURE 26**. An exponential rate suggests that bushmeat imports are increasing in a way that is similar to human population growth - with a doubling each year of the amount of bushmeat being smuggled into Switzerland. From these results, we predict that Switzerland can expect more bushmeat to arrive in the coming years.

FIGURE 25: The amount (in kg) of all confiscations recognized/recorded by Swiss Customs agents as bushmeat or wild meat in passenger luggage arriving in Zürich Flughafen and in Genève Aéroport from 2008-2012.

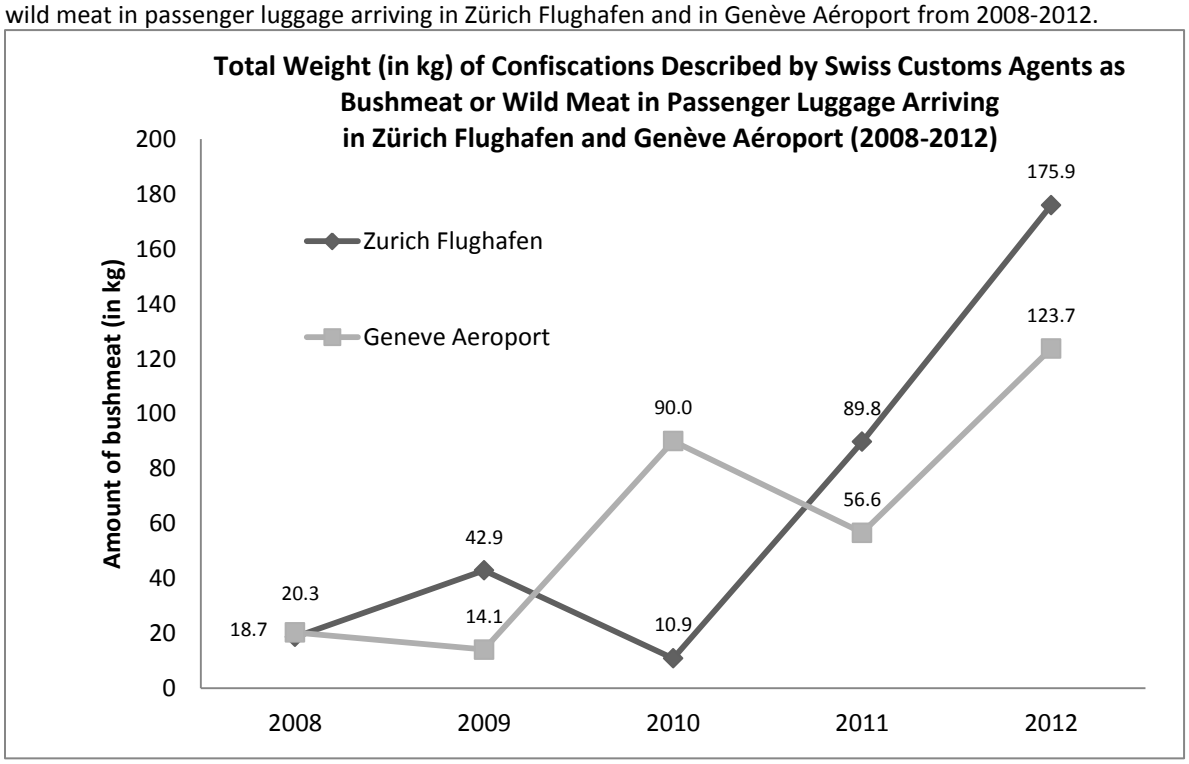
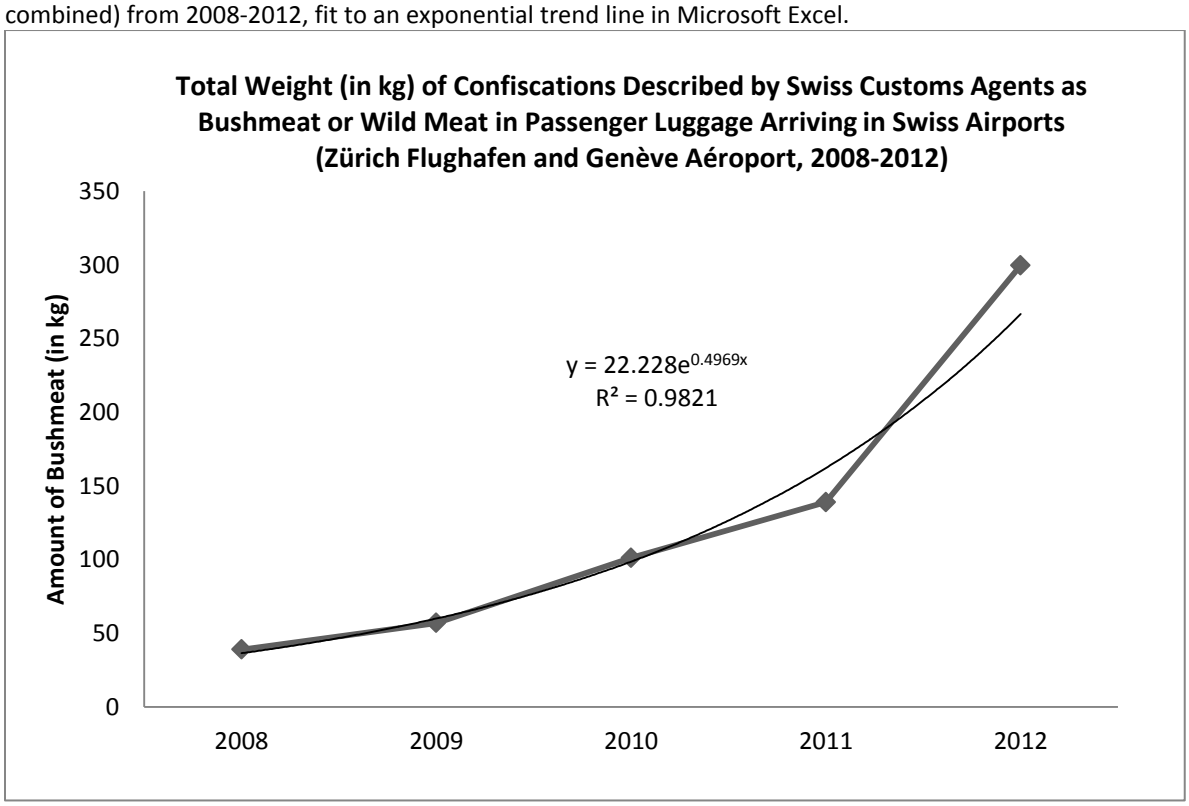


FIGURE 26: The amount (in kg) of all confiscations that were recognized/recorded by Swiss customs agents as bushmeat or wild meat arriving in passenger luggage in Swiss Airports (Zürich Flughafen and Genève Aéroport combined) from 2008-2012, fit to an exponential trend line in Microsoft Excel.



DISCUSSION:

DISCUSSION:

The Problem of Bushmeat Smuggling into Switzerland

One of the main problems with addressing the issue of bushmeat involves *finding and identifying* bushmeat that has been smuggled into Switzerland. We have already shown that bushmeat can be difficult to identify from other types of meats. Therefore, one of the main goals of this study included resolving difficulties in this regard. To this end, we described some predictive morphological features and characteristics of bushmeat. We also identified regions, flights and airlines of concern in regard to bushmeat smugglers. Through the use of advanced DNA techniques, we were able to identify meats to the species level and therefore definitively determine CITES-listings for these smuggled meats. From control day searches and amounts of known bushmeat confiscated, we estimated how much bushmeat may be arriving annually in Switzerland. In this section, we also explore some of the issues of how and why bushmeat travels to Switzerland.

The concerns in regard to the import of wild meat into Switzerland involve two important issues. The first concern is ***conservation of species***, as the trade in bushmeat could be having an impact the survival of some highly trafficked species. Results from this study prove that Switzerland is not immune to the illegal trafficking of wild species as bushmeat, putting species at risk from the demand for wild meat inside Switzerland, and this issue is discussed in Section II. The second concern is the risks bushmeat poses to ***food security and public health*** through the introduction of disease to naïve Swiss populations. Imports of bushmeat can have serious negative effects on public health and the economy of Switzerland, as well as on the health of native species of animals and plants, and this issue is discussed in Section III. It is hoped that the results and recommendations from this study will be used to more effectively search for bushmeat at Swiss borders and to help curtail this problem in Switzerland, as well as in other developed world ports.

I. THE PATH OF BUSHMEAT; FROM AFRICA TO EUROPE

Bushmeat is Being Imported into Many European and Other Developed World Ports of Entry

The hunting of animals inside Africa is considered unsustainable and thought to be one of the greatest and most immediate threats to the survival of African wildlife (Milner-Gulland et al 2003; Robinson and Bennett 2000). *This is without even considering its illegal export to other continents.* While higher profile smuggling of wildlife parts from charismatic megafauna, such as elephant ivory and rhino horns capture the public's attention, the problem of wild meat remains a largely unknown aspect of the international trade in wildlife products. But the depletion of species through this trade is happening on a daily basis in airports the world over. And while global estimates for the trade are rare, it is known to be on the increase - a fact that intuitively makes sense when considered in relation to increases in human population growth (Godfray et al 2010), technological advances which have resulted in ease of global movement, and finally, the high profits provided by the trade (Roe 2008; Dalberg 2012).

Seizures of bushmeat are known to occur with some frequency in many ports of entry in Europe, including but not limited to airports in France (Paris, Toulouse), the U.K. (London), Belgium (Brussels), the Netherlands (Amsterdam), Portugal (Lisbon), Germany (Frankfurt, Münich, Münster, and Berlin) and from this study, Switzerland (Zürich, Geneva, and Basel). Other major developed world ports are also familiar with bushmeat seizures, including many airports in the United States (New York, Los Angeles, Miami, Boston, Chicago, Louisville, Minneapolis and St. Paul, San Francisco and a number of other cities)

and in Canada (Toronto, Montreal) (USFAW 2004; POST 2005; Milius 2005; Marris 2006; Barry 2007; Nasi et al 2008; Wyler 2008; Ogden 2009; Honan 2009; Chaber 2010; Schmadeke 2010; Brashares et al 2011; Elton 2013). While less developed regions with large forest areas in Africa, Asia, and South America may be more likely to be *exporting* bushmeat, the problem of bushmeat *imports* is likely to be occurring in every major developed world airport and shipping port worldwide. The smuggling of wild meats is a widespread, but little publicized problem.

Africa as a Region of Concern in Regard to Bushmeat Imports

Africa, in particular West or Central African countries, were responsible for the majority of bushmeat being smuggled into Switzerland, in both this study and in the analysis of Swiss Customs records from 2008-2011 (Falk et al 2013). Passengers from West and Central African countries (Cameroon, the Democratic Republic of Congo, Nigeria, Ivory Coast, and Togo) smuggled the overwhelming majority (close to 90%) of the bushmeat into Switzerland in this study, with East Africa, and to a lesser extent, South Africa, responsible for most of the remainder. Passengers arriving from all other regions were responsible for only a very small amount of the total wild meat. This trend was also evident in the Chaber study, where the highest proportion of bushmeat was found to arrive in Paris with passengers from Central African Republic and Cameroon, with Cameroon smuggling more kilograms of bushmeat into Paris than any other country (Chaber 2009). In the U.S., a study by Bair-Brake et al (2013) from Customs Records covering the period of 2005-2010 found the majority (95%) of bushmeat that arrives in U.S. ports comes from West African countries, with most of this (80%) arriving from Ghana, Nigeria, Cameroon Ivory Coast, and Togo.

In comparison to other regions, a higher proportion of the total meats confiscated from African countries were found to be bushmeat; 14-17% of meat confiscations arriving from Africa were described in the Swiss Customs Records for 2012 as wild animal meat or bushmeat (see **FIGURE 2**). Again, the Chaber study mirrored this trend; 8-16% of the passengers arriving in Paris on direct flights from West and Central African countries were carrying bushmeat as opposed to domestic meats or fish (Chaber 2009). Our study and the Chaber study also found that bushmeat confiscations tend to be larger than all other types of meat confiscations. These results show that passengers arriving from West and Central African countries are more likely than passengers from other countries to be smuggling bushmeat, and when the smuggled meats were derived from wild animals, they often carried larger amounts of meat than other passengers.

West and Central African Airports; Cameroon and Brussels Belgium as Hubs for Bushmeat Export

In this study, by far the majority of bushmeat arrived on flights from Cameroon. The Chaber study also found Cameroon to smuggle the highest amount of bushmeat and estimated that approximately 3 tonnes of bushmeat per week is smuggled into Paris from this one country. The information that Cameroon is responsible for the vast majority of bushmeat arriving on Swiss soil (close to 80% of all illegally smuggled bushmeat in this study) and may be a hub for transporting bushmeat to at least two European countries (Switzerland and France) - is new. It suggests that the airport in Douala, Cameroon may be a hub for bushmeat exports out of Africa. This is an important result, as the identification of regions of concern in the smuggling of bushmeat into and through European airports will allow customs agents to better target which passengers, airlines, and flights may be carrying wild species, of which 1 in 3 species are likely to be CITES-listed. Our results reveal that wildlife from the West/Central African region, especially endangered and threatened species from Cameroon and its surrounding regions, are at highest risk from the bushmeat trade in Switzerland.

The domination of the West/Central African region in bushmeat imports is not unexpected, as the bushmeat problem is substantial in this region. Also relevant is the fact that the airport in Douala, Cameroon (*Douala International Airport/Aéroport international de Douala*) is a central connector for domestic flights in transit to Europe from other African countries and for a number of direct flights to European destinations, some of which run daily. Information from this study identified the airport in Brussels, Belgium (*Brussels Airport/Brussel Nationaal/Bruxelles-National/Brussel-Zaventem*) as a major transit point for bushmeat coming into Switzerland, suggesting that this airport may be a hub for the distribution of bushmeat *inside* Europe. Brussels Airlines currently offers some of the most inexpensive flights between Africa and Europe (Brussels Airlines 2013), including flights from West/Central African countries which also run daily. The opening of borders in Europe is also likely to have resulted in ease of distribution throughout Europe for bushmeat smugglers. Paris, France was identified in this study as the second most frequent transit point for bushmeat arriving in Switzerland and the Chaber study has already shown that approximately 273 tonnes of bushmeat arrive annually in passenger luggage at Paris' *Charles De Gualle Airport* (*Aéroport de Paris-Charles-de-Gaulle/Roissey*) *from direct Air France flights from West/Central Africa alone*, suggesting that Paris' CDG Airport, which has a number of direct flights from Africa, may be another distribution point for bushmeat moving into Europe.

Native languages may play an indirect role in the regional smuggling of bushmeat. The majority of Cameroon is French speaking, as are the countries of Belgium, France, and parts of Switzerland, including the Canton of Geneva, where one of the airports in this study is located. Bair-Brake's study in U.S. Airports (2013) found the majority of bushmeat confiscations into U.S. in the past 5 years to arrive from West African countries; however, 68% of U.S. confiscations of bushmeat came from Nigeria or Ghana, both of which have major airports with direct flights to U.S., or flights to U.S. via Europe (*Murtala Muhammed International Airport* in Lagos, Nigeria and *Kotoka International Airport* in Accra, Ghana) and both of which are English speaking regions.

The Consumption of Wild Meat – A 'Taste of Home' or a New Trend toward Eating 'Exotic Meats'

Why is bushmeat coming into Switzerland at all? For African immigrants, bushmeat may represent a ***'taste of home'***. There is cultural significance in eating bushmeat; it is traditionally eaten around Christmas or at special occasions (Cowlishaw et al 2004). Bushmeat is also used in traditional remedies and religious ceremonies (King 1994; Sodeinde and Soewu 1996, 1999; Costa-Neto 2005; Dedeke et al 2006; Soewu 2008). In some cases, 'high end' bushmeat, such as primates or big cats, infers status to the consumer as a statement of power or wealth.

For the developed world consumer, ***'exotic' meats*** are becoming more and more popular, both in Europe and in the U.S. (Allen 2010; Consumer 2013). The trend toward buying exotic meats is evident; one need only search the term 'exotic meat' (*exotisches fleisch*) online to find numerous websites to purchase various species, as well as articles and online clubs devoted to the preparation and consumption of wild meat, and popular videos/television shows promoting 'adventurous eating'. Consumption of exotic meat by the developed world consumer may satisfy a need for adventure, or bestow uniqueness or luxury status on the consumer. Wild meat has also been touted as 'healthier' as wild species often have higher or lower levels of protein and fat in their meat than domestic species, although this varies dependent on species (Hoffman and Cawthorn 2012). With the present trends in factory farming in some countries that include such unhealthy practices as the addition of antibiotics and growth hormones to increase domestic meat production, wild meat may seem to offer a more natural diet. However, wild meat also has the potential to harbor diseases that can seriously impact public health. The trend toward the consumption of exotic meats by developed world consumers, when the necessity of conserving species is also recognized, is troubling.

Consumers who purchase exotic meats may assume that the meat was obtained through legal, sustainable hunting or game farms and search no further into its origin. In reality, sustainable hunting and practices to procure exotic meat, as well as hygienic and humane animal welfare practices to process it, may not be in place. Even when an online supplier of exotic meats may have obtained the necessary CITES paperwork to import/export wild meats, the supplier as well as the consumer may have little idea of the true source of the meat, or of the quality control measures in place in its country of origin. The recent scandal involving horsemeat mislabeled as ground beef (Food Safety Authority of Ireland 2013a, 2013b, Hickman 2013; UK House of Commons 2013), and other studies from regions across the world documenting the presence of species other than what is labeled on the packaging, highlight that this problem is widespread. In the U.S., seafood studies showed that as much as 25-70% of the fish commonly sold in supermarkets and restaurants are mislabeled, and in sushi restaurants, the figures were even higher (Buck 2010; Stiles et al 2011; Abelson and Daley 2011; Zisser et al 2012; Warner et al 2013). In a follow-up to the horsemeat study in South Africa, 68% of processed meat samples from markets and butchers contained species not declared on the packaging, including donkey and water buffalo (Cawthorn et al 2012, 2013). Another study by Peppin authenticated meats sold by an exotic meat supplier in the U.K. found that meats labeled as 1.) Kudu, 2.) Impala, 3.) Bison and 4.) Springbuck were instead identified in DNA analysis as 1.) Roe Deer, 2.) Blue Wildebeest, 3.) Domestic Cow, and 4.) Bontebok (Ogden 2009). The exotic meat industry, often sourcing meats from many different places, provides ample opportunity for fraud.

Mislabeling can even be demonstrated using an example from this study; 1 confiscation (a canned tin of 'Mai Ling chicken luncheon meat') originated in China on the label, and was carried to Switzerland by a South African passenger via a flight from Israel. In our DNA analysis, the meat inside the can was identified not as chicken, but rather as mallard duck (*Anas platyrhynchos*). Besides mislabeling, the product is also likely to be a counterfeit of a popular canned luncheon meat brand known as 'Ma Ling', similarly packaged and made by a Shanghai-based food company. Other incidents of counterfeit Ma Ling luncheon meat cans have been reported in Asian news, and were alleged to contain cat and rat meat (Lo 1999; Macairan 2007; GMA News 2007). This one example demonstrates the uncertainty present in all aspects of meat origin.

More resources need to be put toward those quality controls which regulate the import of meats, as well as toward the development of educational materials to inform people of the risks they are exposing themselves to when they buy and consume these 'exotic' meats, including the potential risks to human health and the over-exploitation of wild populations where these meats are sourced. Whether it be consumption by West/Central African immigrants yearning for a ‘taste of home’, or people from other cultures looking for something new and different, the practice of eating 'exotic' meats is one of concern. Changing the behavior of people, however, may be one of the most difficult aspects of the trade.

Ease of Transport and Ports of Entry – How Does Bushmeat Travel to Switzerland?

Trafficking in bushmeat and other wild animal products is a problem now occurring on a global scale, and facilitated by the growing ease of transport via air travel and other methods of fast, long distance movement over established trade routes. Animal products such as bushmeat leave their country of origin via this global network, where planes, ships and other modes of transport move between countries with ease. This means that the most important locations for controlling illegal wildlife smuggling are at a given country’s ports of exit and entry. However, the regulatory personnel in these ports of arrival have numerous areas of concern (i.e. drug trafficking, human trafficking, arms trafficking, regulation/taxation of imported and counterfeit goods, etc.), and environmental protection is unfortunately often of lower priority in regard to a country’s policies. Countries which allow the ***illegal***

export of wild animal products have inadequate export laws and regulations protecting species inside their country, and countries that unknowingly ***import illegal*** wild animal products often have inadequate policies in place to protect species at border points of entry, or few resources to devote to this concern. The net result of this is that illegal wildlife smuggling often meets little to no resistance all the way along the routes it travels.

In addition to air traffic passengers smuggling bushmeat in personal luggage, a substantial amount of bushmeat in this study – close to 20% - was found in air cargo shipments. Over 200,000 tonnes of cargo arrived in Flughafen Zürich in 2012 (Flughafen Zürich 2012) and close to 75,000 tonnes in Geneva (Geneve Aeroport 2012). Cargo shipments via air are typically larger in volume than passenger luggage, and therefore more difficult and less likely to be searched. One confiscation in this study included pieced bushmeat, wrapped and *hidden* inside a sack of peanuts within a larger cargo consignment of *legally* imported food products from Cameroon (SDA 2011), demonstrating that organized smuggling methods for bushmeat are already present in Switzerland. The *legally* imported food in this shipment was headed for Swiss markets – making it very possible that the bushmeat was heading for a counterpart *illegal* black market for bushmeat inside Switzerland.

Very few studies have published information in regard to wildlife smuggling into Switzerland (Geser 2004; Läubli 2010). The study by Läubli (Vetsuisse) addressed the likelihood of bird flu entering Switzerland via live animals or wildlife products; seizure records from Swiss borders in 2006 showed that the most frequently smuggled animal item was ***meat and meat products*** (77% of all seizures). The Läubli study also showed that the personal luggage of airport passengers described only a small portion (4%) of the overall seizure records of live animals and animal products confiscated at Swiss borders, with road traffic responsible for the highest proportion of seizures (93% of the total seizures - significantly more than that seized from commercial air passengers). An incidence of bushmeat smuggling by road was recently documented; 16 kg of bushmeat, including crocodile, python, and CITES-listed pangolins from Cameroon, was seized by Customs agents as it was being smuggled over the border between St. Louis France and Basel, Switzerland, wrapped in plastic in the trunk of a car (SDA 2014). Roads are particularly worrisome as they provide multiple entry points for bushmeat smuggling. Cargo containers aboard ships are another route for smugglers; 90% of the world's trade is carried via ships (Kaluza 2010) and refrigerated containers are known to have been used for smuggling bushmeat and other illegal wildlife products into U.S. ports, where illegal items are often hidden under legally imported products (Goldman 2007; Ferrior 2009; Bair-Brake et al 2013). Our study documents *only* the problem of bushmeat smuggling *into 2 Swiss airports*. However, other types of trade routes need to be rigorously investigated to determine the risk from the various methods of transport in regard to illegal bushmeat imports. It is quite likely that a number of methods other than the passenger luggage and cargo of planes may be used for smuggling wildlife products into Switzerland, including trains (freight/cargo), commercial trucks, mail, and private cars.

Wildlife Trafficking – Monetary Gains Drive the Trade into Europe

According to CITES, the ***legal*** *international wildlife trade* today alone is *"estimated to be worth billions of dollars and to include hundreds of millions of plant and animal specimens"* (CITES 2013b). A report by the non-governmental organization TRAFFIC (Trade Records Analysis of Flora and Fauna in Commerce), a wildlife trade-monitoring program of the IUCN (International Union for the World Conservation of Nature) and WWF (World Wildlife Fund), estimated that the component of the ***legal*** trade of wildlife products into the EU alone was worth nearly €100 billion Euro/300 billion $USD in 2005 (Roe 2008; TRAFFIC 2013a). While consumption of some wild species may be legal inside Africa, export of those wild species that are considered threatened/endangered is not permitted, and in Europe the import of any

type of meat, regardless of species, is not permitted, making bushmeat a commodity which must be ***illegally smuggled*** into Europe. However, it is estimated that the bushmeat trade *inside West and Central Africa* represents 6 million tons of animals consumed annually (Fa et al 2002) at a value in millions of $USD (Cowlishaw et al 2004; POST 2005; Brashares et al 2011; Nasi et al 2011).

By its very nature, the ***illegal*** trade in bushmeat into Europe is problematic to quantify. As part of a black market trade, information becomes difficult or dangerous to obtain and substantiated figures don't exist. The most recent independent reports by Haken (2011) and Dalberg/WWF (2012) rank the trade in illegal wildlife products below only drugs, humans, counterfeit products, and oil in profits for the smugglers and estimate its value at $7.8 to $10 billion $USD, although this is likely to be an underestimate. Most estimates for the proportion of the wildlife trade that is *illegal* put it somewhere around 10–20%, or up to 1/3 (33%) of the legal traffic (Cook 2002; Shactman 2012a, 2012b; Cota-Larson 2013), with the result that illegal trade in wildlife would approximate $30-100 billion $USD. Others have suggested the proportion may be even higher; Karesh et al (2005) estimates 25% of wildlife traffic is illegal, and the Coalition Against Wildlife Trafficking (CAWT 2013) cites a figure of 25-75% of the legal trade. It is important to note that most estimates of the volume of illegal trade in developed world countries are *based on records of Customs seizures at ports of entry* (TRAFFIC 2013a, 2013b; Interpol 2010, 2013; DEFRA 2011; Ferrior 2009; USFAW 2004, 2011). Because ***seizures represent only a small proportion of the total illegal traffic***, estimates derived from these may not be adequate to measure the volume and more in depth investigations into the illegal component of the trade must occur.

Economics of the Bushmeat Trade - A Lucrative Market and Organized Sales

The international bushmeat trade is likely to be influenced by the same type of high profits that can be garnered for other types of illegal wildlife smuggling and a demand by ***consumers in developed countries*** is a key component driving the bushmeat trade. While some of the wild meat that is smuggled into Europe is on a small scale (i.e. for personal consumption only), some is likely being smuggled on a larger, trade scale (i.e. to be sold in specialty markets or restaurants in Europe); this part of the bushmeat trade is financially lucrative, as certain species or types of meat can bring much higher prices in Europe than they do in Africa (Chaber 2009, 2010; ZSL 2010; UK Bushmeat Working Group 2009).

Market value of a product is based on the interaction between consumer demand and availability of the product - in the case of bushmeat, the rarity/difficulty of obtaining a species - and prices reflect this. A recent study by Brashares et al (2011) defined the complexity of economic drivers for bushmeat and showed that the further meat travels from the forest, the higher its cost. While poverty stricken people dwelling far from urban areas were found to be more likely to consume meat they hunted, it was wealthier people living near urban areas who ate the most bushmeat. And the closer a hunter lived to an urban area, the more likely he was to sell bushmeat for profit rather than consume it. The most extreme example of this trend would of course be black market sales in Europe, where a smoked duiker was found to be ***17-25 times more expensive*** than in Africa. The Chaber (2010) study looked briefly into Paris markets and found that bushmeat was part of an organized trade there and considered a luxury item for buyers. For example, prices for a 4kg monkey in a Paris market were ***20 times higher*** than if the same monkey was bought in Cameroon - approximately €100 in France, compared with €5 in Cameroon (Chaber et al 2009, 2010; UK Bushmeat Working Group 2009). Chaber also noted cane rats and porcupines were available in Paris markets for 40€, crocodiles and smoked fish for 20-30€ per kg, and that bushmeat could be found in restaurants in Paris as well. A 2005 Customs intelligence assessment in the UK found that 2% of illegally smuggled meats were from wild species and suggested that organized groups may be involved, as cane rats purchased for £7 in Ghana could be sold in the UK for up to £150 (NAO 2005). The BBC also uncovered sales of illegal wild meat in London's markets (BBC 2001a, 2001b)

and Ogden (2009) priced cane Rats there at £80/kg. These European prices for bushmeat are much higher than the same meat would generate anywhere in Africa. Brashares ongoing work has documented bushmeat markets in a number of developed world cities, including Paris, Brussels, London, New York, Los Angeles, Toronto, and Montreal (Elton 2013). Over a 20 month survey period, a total of 6,000 kilograms of illegally smuggled bushmeat was moved through these markets each month (Marris 2006). Others have documented bushmeat in European markets and restaurants in Paris, Brussels, and London (Cumiskey and Woods 1999; Tan 2004; Southern 2004; Ellicott 2011; Oger 2011; Lynn 2012). Bushmeat sales in specialty shops have even been exposed in Switzerland (Szenogrady 2008; Stadt Opfikon 2008; Schweizer 2009; SDA 2011).

While there is a current international focus on the illegal trade in some high value wildlife products, such as rhino horn and elephant ivory, there is much less awareness of wild meat as a globally traded commodity. The high profits generated by the wildlife trade have resulted in more organized criminal elements becoming involved (Sellar 2007; Koski 2007; Haken 2011; South and Wyatt 2011; Dalberg/WWF 2012; Wyler 2013), which in turn is likely to result in increases in amounts being smuggled. Because sales of bushmeat in the developed world result in very high profit margins and the penalities in place to curb it are few, it becomes very likely that bushmeat is one of the wildlife products whose trafficking is becoming more organized and for which the amounts being smuggled are increasing. This study has already provided some evidence for this – the amount of bushmeat smuggled into Swiss airports is increasing each year. Confiscations of bushmeat were heavier than all other meat confiscations, with those that included CITES-listed species the heaviest confiscations in the study. CITES-listed species cost more than other wild species in European markets, increasing the incentive for smugglers, who can profess ignorance if caught by Customs and are less likely to incur penalties or fines than with other types of smuggling. As a result, bushmeat smugglers have very high profit margins.

II. THE CONSERVATION OF SPECIES

Species at Risk from the Bushmeat Trade in Switzerland

Estimated monetary values for bushmeat take into account *only* the *consumptive value* of the meat (i.e. its value to the human consumer). Animals perform a number of diverse, functional ecosystem services, such as seed dispersal and its subsequent effect on forest plant structure (Moore 2001; Brodie et al 2009; Harrison 2011; Wilkie et al 2011). A change in the numbers of one species often has an impact on another species; for example, the number of predators can impact the number of prey species and likewise, a change in herbivorous patterns of grazing and browsing species can affect the composition of plants (Nasi et al 2011). In short, loss of a species within an ecosystem can impact many other species. The relationship between species within ecosystems being exploited for bushmeat is complex and not well-studied, and while the value of each species within its ecosystem is difficult to measure, the loss of one species can impact overall ecosystem function, species composition, and biodiversity.

The Smuggling of CITES-Listed Species

In this study, we have shown that a number of species are at risk from the bushmeat trade in Switzerland. Three of the most frequently found animal groups in Swiss airports – ***ungulates***, ***rodents***, and ***primates*** – are also the most common types of animals found in bushmeat markets in West and Central Africa (Ntiamoa-Baidu 1997; Fa et al 2006; Nasi et al 2011). These 3 animal groups with the addition of a fourth – ***pangolins*** – ranked highest in the number of samples and the total kilograms of bushmeat found during this study. Most surprisingly, ***1/3 of the bushmeat arriving in Switzerland came from CITES-listed species***. Two animal groups for which all species are included in the CITES Appendices

are ***primates*** and ***pangolins***; these were found at a high frequency during this study and because of this, we consider these two CITES-listed animal groups to be at highest risk. To a lesser extent, species of ***duikers***, ***carnivores*** (otters) and ***reptiles*** (tortoises) have species listed under the CITES convention Appendices that were found during the study and are therefore also considered at high risk. The specific CITES-listed species found during this study as part of the illegal bushmeat trade in Swiss airports include African pangolins (*Manis* spp.), Guenon monkeys (*Cercopithecus* spp.), the Blue duiker (*Philantomba monticola*), the Bay duiker (*Cephalophus dorsalis*), the African forest hinge-back tortoise (*Kinixys erosa*), and the African clawless otter (*Aonyx capensis*). Our result that approximately *1/3 of the bushmeat arriving in Swiss Airports originated from CITES-listed species* was also found in the Chaber study. Over one-third (39%) of bushmeat species identified in the CDG airport in Paris were CITES-listed. The species found in CDG airport were also very similar to those species found in Swiss Airports.

Another important finding in regard to CITES-listed species was that ***confiscations containing CITES-listed species weighed significantly more*** *than bushmeat confiscations that did not contain CITES-listed species*. This is a disturbing but important finding, as it suggests that CITES-listed species are being more heavily trafficked on an international level than non-CITES species. It may be that CITES-listed species are more desirable to developed world bushmeat eaters, or more expensive and therefore a more lucrative type of bushmeat to traffic. Regardless of the reasons, this finding suggests the trade focuses on CITES-listed species over other wild species.

Of Primates, Pangolins, and other Protected Fauna

We used primates as an indicator species in this study because all species of primates are listed in the CITES Appendices and therefore finding them in Swiss airport implies that the international bushmeat trade may be having an impact on vulnerable species of primates. A market demand for vulnerable species guarantees that as they become rarer/depleted in forests (and subsequently in markets) they are likely to become more expensive, and therefore more rewarding for hunters to procure. A study by Reid et al (2005) looked at primates in Bioko, Equatorial Guinea markets and found that as the demand for primate bushmeat rose, supply became more difficult (i.e. populations on Bioko were decreasing). As supply fell, the cost of primates in the market increased, as did hunter profits for killing rarer species, creating a circular problem. Rarity drives prices up, and higher profits are then the incentive to more actively hunt these rare species. Due to their tendency to live in social groups, a large number of individuals may be killed at one time, making primates particularly lucrative when they are found by hunters (Linder and Oates 2011).

Primates

Primates were indeed found as bushmeat in Swiss airports, with at least 3 species of Guenon (*Cercopithecus* spp.) confiscated in 2012. *Cercopithecus* species are underrepresented in the online DNA databank and was the reason they were identified only to genus level in this study. However, there are at least 24 known species of guenon and approximately 55 subspecies, of which around 40% are considered vulnerable, endangered, or critically endangered (Butynski 2002a; Oates et al 2008; IUCN 2013a). Most are not well-studied and there is inadequate information to assess the level of threat to many of these species in the wild (Bourlière et al 1988; Glen and Cords 2002; Butynski 2002b; Oates et al 2008). However, *Cercopithecus* species are known to be under heavy hunting pressure in Africa as the larger-bodied primates become locally hunted out, and in the regions where the specimens found during this study are likely to have originated, they are one of the more commonly found species in bushmeat markets, as well as a preferred taste (Ntiamoa-Baidu 1997; Fa et al 2006; Wilcox and Nambu 2007; Wright and Priston 2010; Covey et al 2011).

A search of the bushmeat literature for West and Central African markets shows that primates can represent anywhere from 0-1% of market catch in heavily depleted areas up to 40% of market catch (Fa et al 2005, 2006, 2009; Fa and Brown 2009; Nasi et al 2011; van Vliet et al 2012). The lower proportions in some areas may reflect the fact that as primate populations are being locally overexploited they are no longer easily found by hunters (Oates et al 2000; Peres 2000; Maisels et al 2001; Hearn and Morra 2001; Isaac and Cowlishaw 2004; Reid et al 2005). In the developed world bushmeat consumer, there is evidence that there may even be a preference for primate meat; Brashares' ongoing study of underground markets in developed world cities estimates that primates may represent as much as **30%** of the black market bushmeat for sale (Elton 2013) - a figure higher than many African markets. In this study, ***primates were the fourth most frequently found animal group and represented 6% of the total bushmeat kilograms***; all arrived on flights originating in Cameroon, where bushmeat market studies show from 1% up to 19.9% of market catch to be primates, with most around 1-4% (Fa et al 2006; Nasi et al 2011). When primates are being found in seizures of wild meats in Switzerland in proportions equal or higher to some local Cameroonian markets, we believe they are especially vulnerable to the international component of the bushmeat trade.

Pangolins

The pangolin (*Manis* spp.) was ***the second most frequently found type of animal in this study***, surpassed only by rodents (the Cane Rat and the African Brush-tailed porcupine). At least 16 individual pangolins were found during the study, all originating from Cameroon, and representing ***14% of the bushmeat kilograms arriving in Switzerland***. All pangolin species are CITES-listed and known to be at extremely high risk from illegal trade, both in Africa and Asia (Challender 2011; Challender et al 2012; IUCN SSC Pangolin Specialist Group 2013; African Pangolin Working Group 2013). The trade in pangolins includes meat for consumption, but also scales and other parts for use in traditional remedies (Sodeinde and Adedipe 1994; Dedeke et al 2006; Soewu 2008; Soewu and Adekanola 2011), with pangolin scales in especially high demand in Asia. At a recent global conference of the IUCN/SSC Pangolin Specialist Group, the status of pangolins were reassessed for the IUCN Red List and all species were evaluated as being in steep decline (Challender 2013). The current trade in pangolins mirrors the situation in rhinos, where illegal trade has increased by over 5000% since 2007 (WWF 2013). Pangolin smuggling figures indicate that thousands of tons of pangolins are being globally traded on an annual basis (Cota-Larson 2013). There is growing evidence that, as Asian pangolins become rarer due to overexploitation, an intercontinental trade in pangolins from Africa to Asia is now in place (Challender and Hywood 2012), with Europe as a transit point for the African pangolins being carried to Asia (Cota-Larson 2013; Mulango 2013). Because of this intercontinental trade, in 2014, CITES has begun to take measures to address the illegal trade in pangolins (CITES 2014) and the IUCN recently upgraded Asian pangolin species to endangered or critically endangered status and all African species to vulnerable (Challender et al 2014). Certainly, this study provides evidence that there is substantial trade in pangolins occurring between Africa and Europe - all of the pangolins found in this study originated from Cameroon and ***of the CITES-listed species found during this study, the pangolin ranked 1st in total number of kilograms*** being smuggled into Swiss airports. Because of this, the Pangolin is the animal we consider at highest risk from the bushmeat trade in Switzerland.

Duikers

Duikers ranked as the ***3rd most commonly found type of bushmeat in this study*** and they are also noted in many bushmeat studies in Africa to be one of the most common market species and a preferred meat. Two of the three most frequently found duiker species in this study, the bay duiker (*Cephalophus dorsalis*, known collectively with some of its sister taxa as 'red duiker' by hunters in Africa), and the blue duiker (*Philantomba monticola*) are CITES-listed because they are heavily hunted for their meat (Wilkie

and Carpenter 1999; Hearn and Morra 2001; van Vliet and Nasi et al 2008; Mockrin 2009) and to a lesser extent for their horns, which are used in traditional medicines (Colyn 2010). One of the species found in this study, the Walter's duiker (*Philantomba walteri*), was only recently discovered as distinct from the Maxwell's Duiker (*P. maxwelli*). Walter's duiker occurs in Togo and the Niger Delta Region of Nigeria, where duiker populations are considered vulnerable, and in Benin, where they are endangered (Colyn 2010). According to a study by Wilkie and Carpenter (1999), the ratio of duikers to rodents found in urban markets may provide a rough index of bushmeat over-exploitation; it is thought that rodents gain popularity in markets when duikers become locally extirpated. The fact that ***seven different duiker species*** were discovered in Swiss airports in a roughly 1 year period, representing ***12% of the total bushmeat kilograms***, is of concern. Couple this with the fact that illegal bushmeat imports into Switzerland were high for both duikers and rodents, and it is an indication that duiker species may be under high pressure from their export out of Africa and onto dinner plates in Switzerland and other European countries.

Carnivores and Reptiles

Two other vulnerable animal groups which included at risk CITES-listed species and were found during this study were small carnivores (otters) and reptiles (land tortoises). The African Clawless Otter (*Aonyx capensis*), a CITES-listed small carnivore found during this study, is hunted and eaten over much of its range (IUCN Otter Specialist Group 2013b). In most regions where it occurs, *Aonyx capensis* is listed under CITES Appendix II; however, the specimen found during this study may have originated from a region where the population is genetically distinct enough to be considered a unique subspecies known as the Congo Clawless Otter (*Aonyx capensis congicus*) and listed under CITES Appendix I (Jacques et al 2009). The CITES-listed reptile found during the study was a Forest hinge-back tortoise (*Kinixys erosa*). Land tortoises (*Testudinidae*) are a family for which all species are CITES-listed due to global overexploitation (Swingland and IUCN/SSC 1989). The conservation status of the Forest hinge-back tortoise (*Kinixys erosa*), the species found during this study, is unknown and they are categorized as 'data deficient' by the IUCN (Tortoise & Freshwater Turtle Specialist Group 1996). However, where this species occurs in West and Central Africa, they are opportunistically utilized for meat (Swingland and IUCN/SSC 1989; Marcot 2004; Luiselli et al 2013; Eniang and Ijeomah 2011; Kindler 2012).

Non-CITES Species Found as Bushmeat during this Study

Other wild animal groups found during this study were diverse and included species of rodents, wild pig, antelope, small carnivores, snakes, crocodiles, birds, fish, snails, and insects. A number of domestic species were also discovered being smuggled as illegal meats, contributing to the risk of disease introduction.

Our result of rodents being the most frequently found type of bushmeat was not unexpected, as the African Brush-tailed porcupine and the Cane rat are also two of the more commonly reported bushmeat species observed in African markets. Neither of these rodents are CITES listed, but both have large body sizes, and together, they represented a substantial portion of the total kilograms of meat found during the study. These species may be two of the more common species hunted in African forests, with the porcupine especially prized for its taste. There have been attempts to create viable alternative protein sources in areas of West and Central Africa by farming both of these species (Falconer 1990; Hardouin 1995; Jori and Chardonnet 2001), along with the Giant African Land Snail (*Achatinidae*) (Ngenwi et al 2010; Hance 2010; Owen and Dike 2012; Wilson 2012). While cane rat and snail farming are moderately successful, the porcupine has been found to have a very low reproductive rate in captivity (Jori 1998). Also problematic is the fact that all of these species still have large enough populations in the wild that

they are considered more easily hunted/collected from the forest than farmed; a deterrent to stimulating captive production.

Besides the duikers, one other ungulate, the Red River Hog (*Potamochoerus porcus*), appears to be at some risk from the international bushmeat trade. While not CITES-listed, this was the ***6th most frequently found species in this study*** and was found in more than one confiscation. In Congo Basin bushmeat studies, the most frequently found ungulates were duikers (*Cephalophinae*) and Red river hogs (*Potamochoerus porcus*)(Wilkie and Carpenter 1999). Together with the duikers, the Red river hog, also known as the 'bush pig', is a preferred meat, and a study in Gabon found Red river hogs to account for 40% of the bushmeat recorded in local markets (IUCN SSC Wild Pig Specialist Group 2013). Another antelope species found during the study was the Sitatunga (*Tragelaphus spekii*), a large antelope often recorded in markets. While neither of these species is CITES-listed, they are both threatened by hunting and forest degradation.

Besides tortoises, two other types of reptiles were confiscated during this study – snakes and crocodile. Reptiles are often found in the international wildlife trade, both in the legal trade (as farmed or wild individuals) and illegally smuggled from the wild; they are utilized for their skins in the fashion trade, but also for their meat. While the Gaboon viper found in our study is not a CITES-listed species, in one study in Nigeria, Gaboon vipers were found in every bushmeat market surveyed (Eniang and Ijeomah 2011). For the specimens identified as *Crocodylidae* in this study, DNA was not able to be extracted and therefore CITES listing is unknown, but a number of species of African crocodiles are included in the CITES Appendices (CITES 2013d).

Although wild fish were not considered bushmeat in this study, it is possible that some indigenous fish species may be threatened by the trade in wild meat. Most fish confiscations that occurred during this study and those described in the customs databases, were species of smoked or dried fishes from Africa, such as the 2 species of African catfish (*Clarias* spp.) identified in the DNA analysis (Froese 2011; FAO 2013). Many native fish populations in West Africa are known to be over-exploited (Kaczynski and Fluharty 2002; Rowcliffe et al 2005; Smith et al 2009; Olusegun 2013) and as local waters become overfished, inexpensive dried or frozen fishes from Nordic regions known as 'ice fish' and 'stockfish', are becoming increasingly popular (Falola 2011). In a 2004 study, only 40% of the 400,000 tonnes of fish imported into Nigeria came from *within* Africa while the rest were imported from the EU and Norway (Watson and Brashares 2004) - a trend that was demonstrated during this study when two species of fish arriving with bushmeat species from Nigeria (Porcupine and Cane Rat) were identified in our DNA results as 2 species of fish typically found in Nordic waters (*Brosme brosme* and *Molva molva*) (FAO 2013). Recent research indicates there may be a link between bushmeat and fish consumption in Africa; analysis of a 30 year database from Ghana revealed that *years with a poor fish supply* coincided with *increased hunting in nature reserves* and *sharp declines in biomass* for 41 wildlife species (Brashares et al 2004). In regard to wild species of fish arriving in Swiss airports, it is also noteworthy that in Switzerland and the EU, up to 20 kilograms of fish are allowed to be imported by any given passenger and it is not possible for Customs officers to identify whether these fish are endangered or threatened species. An example of this is a confiscation of unknown meat from Singapore on one of the control days, later identified in the DNA analyses as a species of stingray (*Himantura* spp.), a genus which includes a number of vulnerable and endangered species (IUCN 2013b).

All of the wild species found in Swiss airports, especially those that are CITES-listed, we consider to be at risk from the bushmeat trade in Switzerland. However, this report cannot fully assess the level of risk to each species from the trade. Our information merely quantifies amounts confiscated, and identifies

those species we consider at highest risk from the bushmeat trade in Switzerland. Our hope is that this report will generate a response both in Switzerland and in other EU countries to improve the procedures that help identify and quantify species at risk from the international trade in bushmeat. The end result of this will be better protection for species in airports and other ports of entry.

III. FOOD SECURITY AND PUBLIC HEALTH

Illegal Meat Smuggling and Disease

Substantial amounts of meats come daily into Swiss airports. The majority of these meats are from domesticated species, but a variety of wild species were also present. While meats from domestic species are not a concern in regard to conservation, all illegally smuggled meats are a concern in regard to disease. Meats carried into Swiss airports are illegally smuggled and as such are *unregulated*. The fate of domestic and wild meats that are not found and confiscated, but instead leave the airport undetected and travel into Switzerland, is unknown, but of significant concern.

The majority of the confiscated meats in this study, including domestic meats, arrived from regions outside Europe, and included countries in Africa, Asia, Eastern Europe, and the Middle East – all areas where livestock diseases that are controlled for or have been eradicated in Switzerland may still be present or endemic. The economics of disease outbreaks in livestock show that they are very costly for countries (Otte et al 2004; Karesh et al 2005; Jones et al 2008; Marsh Inc 2008); Foot and mouth disease, for example, is problematic in Sub-Saharan Africa as it is endemic in African cattle and also present in wild animals, including the African buffalo, which can be a carrier of this disease (Vosloo et al 2002, 2004; Karesh 2012). The addition of illegally imported meats to pig swill is thought to have caused the 2001 outbreak Foot and Mouth Disease (Scudamore and Harris 2002; Wooldridge 2006; Hartnett 2008) which cost the U.K. an estimated 3.1 billion dollars and forced the slaughter of close to 7 million cattle and sheep (Thomson et al 2002; BBC 2002; Watkiss and Smith 2005). Since that time, the U.K. has had a much higher awareness and tighter controls in place in regard to the import of illegal meats, including bushmeat (DEFRA 2002; Wooldridge 2006; McEwing and Ogden 2006; UK Bushmeat Working Group 2013a, 2013b; DEFRA 2011). Switzerland has effectively eradicated FMD and a number of other diseases (FVO/BVET 2012). But the examples provided by the U.K. 2001 FMD outbreak and the recent discovery of widespread, worldwide mislabeling of meats, reveal that meat origin is difficult to trace, even for legal imports. Stricter regulatory oversight and more resources may be needed to effectively address this problem.

The smuggling of *wild meats* is of particular concern as they can play a role in the emergence of little-known infectious diseases from previously undisturbed animal reservoirs (Kimball 2006; Brown 2010). Bushmeat has a higher potential to cause an emergent disease outbreak than meats from domesticated animals, which have co-existed beside man for centuries (Karesh et al 2005; Marano et al 2007; Pavlin et al 2009; Peeters et al 2002; Chomel 2007; Belant and Deese 2010). One of the small carnivores found in this study was the African palm civet (*Nandinia binotata*); this species is similar to another small carnivore, the Asian Palm civet (*Paguma larvata*), which gained notoriety during the 2003 SARS epidemic when the disease was first detected in this species and other small carnivores being sold in Asian markets (Guan et al 2003; Bell 2004; Van Rompaey et al 2008). Although recent research indicates that bats may be the natural reservoir for SARS (Li et al 2005; Wang et al 2006), the disease is thought to have passed between humans and small carnivores in the markets, where wildlife species were being traded. Evidence of exposure to the virus was higher in animal traders than in all other human populations in the region (Bell 2004), implying that the wildlife market trade can play a role in the

emergence of new diseases by placing species that would not interact in the wild in very close proximity to one another.

Rodents and primates, two types of wild animals that were smuggled as bushmeat into Switzerland, are of particular concern in regard to disease transmission. Primates, especially the great apes, are a known risk in regard to emergent disease because of their genetic similarities to humans (Peeters et al 2002). Species of primates were also found in the Chaber (2010) study at CDG airport in Paris and the Smith (2011) study of diseases entering U.S. airports; in this study, primates ranked 4th highest in total kilograms, demonstrating a potential entry route for emergent disease. In regard to rodents, in both the Smith study, as well as in the Chaber study, rodents were the most frequently found species; in our study also, rodents ranked first, with over 100 kilograms of two rodent species - the African brush-tailed porcupine (*Atherurus africanus*) and the Greater Cane Rat (*Thryonomys swinderianus*) - found in luggage or cargo coming into Switzerland. Another frequently found species in this study, the Giant African Land Snail (*Achatina* and *Archachatina* spp.) is known to carry a number of diseases of concern. In addition to disease concerns, in regions of the U.S., the Caribbean, and South America where these species of snails have been accidentally introduced, they eat hundreds of plant species and are considered one of the most destructive invasive species to agriculture and the environment (USDA-APHIS 2005; Thiengo et al 2007; USDA 2011).

According to a study by Keesing et al (2010), at least 2% of *emergent infectious disease events* during the period from 1940 to 2005 have been traced directly to *bushmeat consumption*. Outbreaks of Ebola in Africa (WHO 2014; CDC 2014) are a good example of one of the worst case scenarios for handling, transport, and consumption of wild meats. An outbreak of Ebola in Gabon in 1996 was traced to 19 villagers who skinned and ate a dead chimpanzee found in the forest, many of whom later died from the virus (Georges et al 1999). During outbreaks from 2001-2003 in Gabon and the Democratic Republic of Congo, an increase in animal mortality in the nearby forests always preceded the first human cases of Ebola (Georges et al 1999; Leroy 2004b) and outbreaks were linked to the handling of dead animals by hunters or villagers. During this period, gorilla researchers found that over 90% of their study group as well as other groups in the surrounding region disappeared (over 200 animals) and they estimated that it is likely 3500-5500 gorillas died of Ebola during this period (Walsh et al 2003; Bermejo et al 2006; Leroy 2004b). The natural host of Ebola is currently thought to be fruit bats (Leroy et al 2004, 2009; FAO 2010; WHO 2014), who may carry the virus without illness, while other animals such as primates and duikers become ill, which may make them more likely to be caught by hunters. Dead animals (gorillas, chimpanzees, and duikers) found in the forest during outbreaks tested positive for the virus, which can live for 3-4 days in carcasses (Leroy et al 2004a, 2004b, 2005; Rouquet et al 2005). Ebola is a good example of how easily one of the most virulent diseases known to man could be transported via airplane to an uninfected region inside an animal carcass. Duikers and primates were both found in Swiss airports during this study and fruit bats are also a very popular bushmeat in Africa that have been discovered in developed world airports and underground markets (Bair-Brake et al 2013; Elton 2013). During the most recent outbreak of Ebola (CDC 2014), the West Africa countries of Guinea, Ivory Coast, Liberia, and Sierra Leone, took a proactive step by initiating 'bushmeat bans', although the effectiveness of these campaigns among Africans who have grown up eating bushmeat and have routinely continued to do so is negligible (Fletcher 2014; Haque 2014).

Smith et al (2011) described their study of viruses found in bushmeat arriving in U.S. Ports of entry as a ‘pilot study’; due to the results of their study, the Centre for Disease Control (CDC) has now begun a monitoring project in major U.S. ports to identify viruses found in illegally trafficked bushmeat (Vastag 2012). We describe our study then as ‘a pilot study for Switzerland’ which identifies important aspects

of the bushmeat problem in Switzerland and prompts further action. This study has already generated a response in regard to emergent disease; the Spiez Laboratory, a Swiss Federal Institute for NBC-Protection (nuclear, biological and chemical hazards) is currently examining some of the bushmeat samples collected in this study for the presence of viruses (Humbel 2013).

Summary Conclusions

Our study is only the first step; more work on the issue is necessary. In this report, we have identified those at risk African species threatened by the import of illegal bushmeat, and described the threat to species conservation and to the people, livestock, agriculture, wildlife, and the economy of Switzerland through the potential introduction of disease. The study has provided a number of insights into the problem of bushmeat smuggling into Switzerland. We have identified those problematic regions from which smuggling occurs and species that are at risk from the trade. Our results demonstrate that bushmeat is present in Switzerland, in amounts that may impact species, and that the amount being smuggled into Switzerland may be increasing at an exponential rate. Our results also suggest it is likely that behind the amount of bushmeat found and confiscated each year by customs, some greater amount is not discovered and arrives on Swiss soil undetected. A number of recommendations to curb the bushmeat problem in Switzerland, and in the larger picture of Europe and the world, are provided in the next section.

RECOMMENDATIONS:

RECOMMENDATIONS:

An Overview of Recommendations from this Study

The problem of illegal bushmeat imports should first be addressed via efforts by those developed world countries into which bushmeat is being illegally smuggled. The collection of information on the bushmeat trade in European countries is essential for both food safety/public health and for the conservation of at risk species. More rigorous analyses of known data sources (i.e. customs records of seizures) will help to monitor and quantify the scale of the problem. Better control of the trade could be accomplished with more effective tools to fight the trade, such as DNA analysis of suspect meats, adequate customs training and staffing, and the presence of trained detection dogs in ports of entry. The most important role of this paper is to provide impetus for changes in those existing protocols, regulations/laws, and national policies that would help to prevent bushmeat being transported into Switzerland and other developed world countries and as a result, more effectively protect species and the public. From the insights gained in this study, we have provided a number of recommendations in this section.

I. CHANGING POLICIES

Switzerland as an Example for Europe – Curbing the Bushmeat Problem on our soil

Bushmeat arriving in Swiss airports is a part of an international, organized trade in wildlife and addressing this issue calls for a coordinated and committed response by Cantonal/ State and National agencies in Switzerland. Once the issues in regard to this problem have been identified, then those political policies that regulate the system can be reviewed, and a determination made as to how they might be changed to better address the bushmeat problem. Switzerland is a world leader, and has some of the strongest environmental/green policies in the world (EPI 2012). It is also the headquarters of CITES, which regulates wild animal traffic worldwide. Switzerland also has a unique and judicious political system, with the potential to effectively change those policies that would curb bushmeat smuggling. These changes could have a positive impact on the health of Switzerland's human and animal populations, and may also have a positive impact in the broader picture of EU and world policies to conserve species.

National Policies; Changes in Penalties and Prosecutions

One of the most critical components of deterring bushmeat smuggling is to have adequate penalties and an effective process in place for prosecuting offenders. At present, environmental crimes such as wildlife trafficking tends to be of lower priority for policy makers in most countries, who focus on higher profile crimes, such as smuggling of drugs, guns, and counterfeit goods (Koski 2007). Even when a case is prosecuted, the fines for smuggling wildlife products tend to be much lower than the expected return for the smuggler when the animal products are sold. Low penalties vs. high profit margins and low risk of getting caught clearly encourage smuggling.

In the case of bushmeat, the status of illegal bushmeat imports under Swiss law is not a crime, but only a misdemeanor; this is the main problem with these imports. If the meat being smuggled is recognized as coming from a CITES-listed or endangered species, fines and prosecution can take place; however, we have already shown that species recognition is difficult. Current fines/penalties for smuggling bushmeat are determined on a case by case basis; if a passenger has not declared the meat, then a fine or penalty can be incurred. However, it is also possible for passengers to declare ignorance of the laws, and in most cases excepting those with large amounts of bushmeat, recognizable CITES-listed species, or repeat offenders, the meat is confiscated, but the passenger is not fined or prosecuted. If the matter is

pursued, the case is first reviewed by Customs, then Border Veterinarians (GTU) and other personnel (BVET/FVO and CITES) are consulted. These agencies determine if a smuggled meat is from a CITES-listed species, and make recommendations to the Swiss Federal Customs Administration (Eidgenössische Zollverwaltung, Oberzolldirektion), who then determine fines and penalties in accordance with Federal laws on marketing of protected species of animals and plants (*Bundesgesetz über den Verkehr mit Tieren und Pflanzen geschützter Arten, BGCites; SR 453*). If prosecuted, the legal process can take up to 3 years, and while fines can be up to 40,000 CHF for smuggling CITES-listed species or for a habitual offender, typical fines incurred for bushmeat are small - between 1,000 and 3,000 CHF, after taking into account the financial circumstances of the smuggler (Pavel 2013).

Existing policies need to be revised and the penalties for smuggling increased in order to more effectively protect species. The smuggling of endangered species should be a ***criminal act***, on par with the smuggling of drugs, guns or counterfeit goods. When the smuggling of wildlife is not considered a crime, fines are small and prosecutions rare. This allows trafficking in wildlife products to generate very high profit margins. Because of this, opportunities to trade are targeted by criminals who use or establish efficient trade routes and smuggling methods. In fact, there is a growing body of evidence that, because of the high and growing profits in wildlife products, trafficking is increasingly attracting more organized criminal elements (Sellar 2007; Koski 2007; Haken 2011; South and Wyatt 2011; Dalberg/WWF 2012; Wyler 2013). The United Nations (UN) recently recognized the problem and adopted a resolution titled “Crime prevention and criminal justice responses to illicit trafficking in protected species of wild fauna and flora” (E/CN.15/2013/L.20/ Rev - CITES 2013f; UNODC 2013, UN CCPCJ 2013). It is time for Switzerland to adopt a similar stance and directly address those policies which will discourage organized wildlife crime and result in better and stronger protection for vulnerable species. The results from this study have already begun to generate a response - a discussion titled '13.3887 Massnahmen gegen den illegalen Buschfleischhandel' (*in English – 'Measures again the illegal bushmeat trade'*) was introduced in Swiss Parliament during the 2013 Nationalrat Wintersession (Humbel 2013) and is the first step in beginning to address the problem in regard to the policies and procedures which must be changed to more effectively protect Swiss citizens and also protect those wild species being trafficked as bushmeat.

Airline and Trans-border Responsibilities

In the Chaber study of bushmeat arriving in Paris via Charles De Gaulle Airport, only *direct Air France* flights from Africa were targeted. In our study, there were very few direct flights from West/Central Africa, the region where most bushmeat originates; instead, targeted flights in the study had connecting flights to Africa or other regions, with surprising results - the four most frequent carriers of bushmeat into Switzerland were SWISS, Brussels Airlines, Air France and cargo flights from Africa. While the origin of most bushmeat is known to be West or Central Africa, the departure point of the majority of flights carrying bushmeat into Switzerland is *inside Europe*. Over half the kilograms identified as bushmeat in this study (62%) arrived in Zürich or Geneva on flights that departed from European Airports, with most from Brussels, Belgium (via SWISS and Brussels Airlines flights) or from Paris, France (via Air France flights). While flights from Brussels and Paris are a very short step within the EU; they nevertheless carried the majority of the bushmeat into Switzerland, complicating the finding of bushmeat.

Brussels Airlines currently provides inexpensive flights from Africa to Europe, and according to our results, may have garnered a large share of the bushmeat traffic from Africa to Europe as well. After the discontinuation of the SWISS direct flight to Cameroon (the LX 275, which carried close to 1/5 of the total bushmeat kilograms into Switzerland during this study, even though this flight ran only until March of 2012), the most frequent flights smuggling bushmeat into Switzerland were codeshare flights of

SWISS and Brussels Airlines (see **TABLE 6**). SWISS planes smuggled the most bushmeat during our study, with Brussels Airlines flights responsible for smuggling the 2nd largest amount. In summary, the majority of bushmeat arrived with transit passengers from Africa, who flew through Brussels Belgium on either a SWISS or Brussels Airlines flight, and disembarked in Switzerland with bushmeat. And about 1/5 of bushmeat smugglers came to Switzerland via Paris, France rather than Belgium. Although this result may be driven by Brussels Airlines and Air France having a higher proportion of *direct* flights from Africa, it still means that Brussels and Paris likely serve as hubs for bushmeat distribution inside Europe.

Clearly, the movement of bushmeat *within Europe* complicates the finding of bushmeat. Within the EU, it is *legal* for passengers to carry meat for personal consumption across borders - under current legislation, meat moving *within* EU countries (including Switzerland) is not subject to seizure (unless it is in large amounts and therefore subject to import laws). The majority of passengers in this study, regardless of their country of origin, were smuggling some type of meat in their luggage that they described as *originating from a country outside of the European Union*, but that nevertheless *arrived in Switzerland on a flight from within Europe*. Complicating the issue further is that fact that bushmeat may leave Africa on the first leg of a passenger's flight unchecked - while regulations do exist in Africa to protect endangered and threatened species and to control the movement of CITES-listed species, some types of meats may be carried within certain countries. Ultimately, the responsibility for whether a meat can be carried/imported is on the *passenger*, who must know the regulations and restrictions in the country they are traveling to. On arrival in Europe, travelers from Africa often protest when meats are confiscated, provide false veterinary certificates, or claim ignorance when the meat is discovered and confiscated.

Airlines and airports can play a role in controlling this problem. Those airlines which have direct or connecting flights from African countries to Europe should be included in the scope of responsibility. Educational campaigns in the form of highly visible posters or brochures in both bushmeat source countries in Africa, where connecting flights depart from, could inform travelers and tourists about what types of meat and meat products cannot be taken into Europe. These posters/brochures could be placed in European airports as well, to inform transit passengers what is not importable *within* Europe. Airlines and flights which have been shown to have a high probability of carrying bushmeat in this and other studies may need to have more stringent measures in place to inform and control passengers. Airlines and Customs agencies could work more closely together on this problem; bushmeat smuggling could be reduced through more effective baggage checks via cooperation efforts between the airlines and Customs agencies to control those bags that are *in transit within Europe* on known problem flights. It is somewhat alarming that, in this study we found that once bushmeat leaves Africa on any flight, regardless of layovers or flight changes, it may not be found until its arrival in Switzerland.

Changes in CITES Regulations at the International Level

On the international level, better enforcement of existing laws by CITES member states is a necessary component in stopping the bushmeat trade. However, this step is fraught with difficulties; false veterinary certifications or false CITES paperwork from third countries, or in some cases, correct paperwork which misrepresents the species being exported, is sometimes provided by wildlife smugglers. While enforcement may be difficult in those CITES member countries outside the developed world, where corruption of law enforcement and government officials provides opportunities for smuggling, the goal of better controls within *all* CITES member countries must nevertheless be in place. For developed world CITES member countries such as Switzerland, which is the headquarters of CITES International, the opportunity to provide an example for others, and play a key role in stopping wildlife trafficking through more effective policies and procedures at ports of entry, is possible.

CITES regulations are in place to protect species *via limiting legal trade*; the addition of stronger protection from internal and external investigations into cases of heavily exploited wild species are a necessity in today's world of organized global trade. High risk species in the bushmeat trade, such as pangolins and duikers should be reevaluated in the CITES listings. We found seven duiker species in one year in Swiss airports - only two of these species are listed in the CITES Appendices as being at risk from the international trade. If possible, all duiker species should be included in the Appendices, as they are one of the most frequently found types of bushmeat. Pangolins were recently described Challender (2013) as being "eaten to extinction" and the threat to these species is compounded by their use in traditional medicines in both Africa and Asia. There is growing evidence that, as pangolins become rarer in Asia through over-hunting, an intercontinental trade from Africa to Asia has begun. Recent confiscations of tonnes of African pangolins in Malaysia and Hong Kong from Cameroon and Kenya provide clear evidence that this intercontinental trade is occurring (Cota Larson 2014a, 2014b; Lo 2014) and our study provides evidence that this trade may be passing through Europe as well. The surprisingly dramatic increases in the trafficking of certain select species of wildlife, such as rhinos, elephants, pangolins and primates over the past several years (Stiles et al 2013; WWF U.K. 2013; CITES 2014a), calls for much more rigorous investigation into what is becoming a far-reaching global problem if these species are to be saved. The addition of a formal investigative body within CITES, with funding to investigate trade violations, is called for.

II. FINDING THE BUSHMEAT: TOOLS TO FIGHT THE TRADE

DNA Testing as a Tool to Fight Bushmeat Smuggling

Wildlife forensics is a growing discipline which promises to aid in the fight against wildlife trafficking (Ogden et al 2009). In the case of bushmeat, genetic techniques can help link illegally seized meats to a species, specific individual, or region, resulting in a prosecutable case. Genetic techniques have long been in use in human criminal investigations and the same techniques have been modified for use in wildlife forensics (Linacre and Tobe 2011; Linacre et al 2010). There are currently a very small number of institutions that specialize in wildlife forensics, but the field is growing in interest and a number of practical techniques for species and individual identification exist (Cooper and Cooper 2007; Linacre 2009; Ogden 2010; Wilson-Wilde 2010; Huffman and Wallace 2011; Cooper and Cooper 2013).

In the Chaber (2010) study of bushmeat arriving at Charles de Gaulle airport in Paris, species were identified visually, and when this was not possible, they were identified using skeletal examination of bone fragments. Our study was substantially strengthened through the use of mtDNA typing of seized meat samples to identify those species at risk in Switzerland from the bushmeat trade (Morf et al 2013), especially in the case of pieced, unrecognizable bushmeat. While fresh muscle tissue is the best case scenario for DNA analysis, the method used in this study proved to be a very versatile one, and worked even with degraded samples. The vast majority of our non-commercially processed meats were identified with ease in the DNA analysis, including those meats that had been aged or unrefrigerated for indeterminate periods, dried, smoked, cooked, and/or spiced, and then placed in refrigeration for long periods of time. The majority of cases in this study for which DNA analyses failed to identify meats were samples from commercially processed and packaged meats from the control days. The method used in this study was robust and very effective in identifying bushmeat to species.

DNA Testing of Meats to Determine a More Accurate Quantity of Bushmeat

In the current scenario, when meat is suspected of originating from a wild species and is confiscated by Customs, it is sent to Border veterinarians (FVO/BVET 2013e) and an attempt is made to identify if it is a

CITES-listed species before disposal. However, as already discussed, identification to species level is often difficult, especially with pieced/smoked bushmeat, and DNA testing is not routinely performed. Meats from CITES-listed species, if not recognized by such as Customs agents or by Border veterinarians, are treated no differently from any other confiscated meats, which are disposed of daily in a bio-safe container, and sent to be burned. Essentially, at risk species such as primates and pangolins may be disposed of along with all other non-descript meats. A great deal of information about the risk to species from the wildlife trade is being lost in this process. The use of DNA is an important step in linking suspect meat to CITES-listed species threatened by illegal trade. With DNA typing, species at risk from the bushmeat trade can be more accurately evaluated. It is also important for creating a strong legal basis in the prosecution of bushmeat cases by Swiss authorities.

The samples that customs agents collected from suspected bushmeat during our study included only those confiscations ***recognized or suspected*** by customs agents as bushmeat. Outside of our 5 control days (where all confiscated meats were sampled) no samples from any other type of meat product not suspected of being bushmeat were collected for DNA testing. This is a whole other class of meat products that were not fully addressed in this study. For the majority of the confiscations suspected of being bushmeat and collected during 2012, customs agents were correct in their recognition of bushmeat. However, features described in this study such as fresh or smoked whole carcasses, partial carcasses and pieces with heads, limbs, bones or pelts attached, or the presence of a foul odor (Pavel 2012) are characteristics that, rather than identifying bushmeat confiscations, may just make *this type of bushmeat confiscation* easier to find than others. It is very possible that some 'cryptic' presentations of bushmeat go unrecognized. In Africa, a typical presentation of bushmeat is a soup or stew; often in a sauce with greens and chopped bushmeat pieces that resemble domestic meats. It is also possible that, in the case of organized smugglers and bushmeat sales slated for higher end markets, meat may be better preserved and packaged to resemble filet-type cuts of domestic meats (Karl Ammann, *pers. comm.*). It is likely that these presentations or cuts of meat from wild species that more closely resemble domestic meats will be overlooked, or described in the customs records only as 'meat' and immediately disposed of. In fact, the majority of meat confiscations in the 2012 customs records are described using only a generic meat label (i.e. 'flesich' or 'viande'); 95% of the meats confiscated in Zürich and 60% of meats collected in Geneva were described as a generic 'meat' (or some type of meat cut or meat product) with no mention of species from which the meat was derived. Therefore, some proportion of bushmeat confiscations, such as the aforementioned soups/stews or filet cuts of bushmeat, may not be recognized or described by customs agents as bushmeat. Only 3 meat 'preparations' (soups/stews) were tested in this study, 1 of which included bushmeat (see **FIGURE 16**). A study which collects a greater number of samples from *all types of confiscated meats* over a longer period of time would help clarify what proportion of the generically labeled 'meat' confiscations collected by Customs agents could in fact be cryptic presentations of bushmeat arriving in Switzerland.

On the Frontlines in Finding Bushmeat – Support for Customs

It is not a secret that only a small proportion of the contraband moving through ports the world over is discovered and confiscated. With few resources and thousands of people to process daily, customs agents worldwide have the odds stacked against them in the fight against wildlife trafficking. As an example of this, in the United States in 2010, there were 15 U.S. Fish and Wildlife (USFAW) inspectors at JFK Airport in New York City, where 46 million passengers and 1.4 million tons of air cargo were processed that year, thousands of tons of which were animals and animal products (Shactman 2012a, 2012b). The effort required for 15 agents to search 46 million passengers would mean that each agent must cover at least 5000 passengers each day of the year (this is not taking into account the 1.4 million tons of cargo).

In this study, search efforts were well coordinated and Swiss customs officials were thorough in their searches of selected passengers. Individual searches can take anywhere from 5-20 minutes, depending on whether or not contraband items are found, and considering that 1.) bags must be x-rayed and thoroughly searched by hand (usually 1 to 3 bags), 2.) passengers must be questioned about suspicious or confiscated items, 3.) agents must confiscate, weigh and dispose of all confiscated items and 4.) enter information about each confiscation into a database, and 5.) agents must fill out paperwork for items which result in fees or prosecutions, and finally, 6.) deal appropriately with often disgruntled passengers throughout this process. Searches are a difficult task, carried out in a very busy environment. Priorities for customs agents are not focused on bushmeat only, but rather on multiple foci, including drug smuggling, arms smuggling, and smuggling of other contraband items, such as tobacco and counterfeit goods. Some items earn hefty fines/fees, and may take focus away from bushmeat and other types of smuggling that have lesser penalties. The sheer volume of people moving through an airport guarantees that finding and confiscating illegally smuggled products is possible for only a small proportion of the total. The same exercise as performed for USFAW above can be done for Swiss Customs; using overall airport volumes of arriving passengers in Zürich and Geneva, if 10 customs agents attempted to capture all illegally smuggled products, each agent would need to search close to 138 passengers per hour in Zürich, and 79 per hour in Geneva - a physical impossibility that would quickly cause long delays on exit.

Because of the time constraints within passenger searches, it is unlikely that a greater number of searches than are currently being conducted are possible. Not all passengers or bags exiting the airport can be searched and therefore not all bushmeat coming into Switzerland is confiscated. Rather, *only a small proportion of the total smuggled bushmeat is discovered and confiscated*. Therefore, the following recommendations are proposed to more efficiently find wildlife items at Swiss borders/ports of entry;

1. Installation of conservation experts at the borders, including cargo and mail shipments
Wildlife experts are a necessary component of customs searches, especially if wildlife trafficking is to be addressed. An on-site wildlife expert, who could work directly with customs during searches and be present when seizures of wildlife products occur, would greatly increase the chances of finding bushmeat and instill a much needed focus on this type of smuggling.

2. More training programs for customs authorities to optimize the visual detection of bushmeat.
A joint effort between Tengwood Organization and BVET has resulted in the creation of a training booklet for Customs and BVET personnel that will help with bushmeat recognition (BLV and Tengwood Organization 2014), a project that was a direct result of this study. Other training programs about bushmeat could expand the knowledge base for customs personnel, and those who are on the frontline of this problem, and are essential to more successfully finding bushmeat.

3. Increased bushmeat controls for passengers, cargo and mail
More ***control days*** focusing specifically on bushmeat from more flights of African origin, and cargo shipments from Africa, may be necessary. Information which allows for more accurate targeting of bushmeat flights is provided in this study and greater knowledge about which European flights connect to African flights is also a key component. Careful evaluation by Customs in selecting the most likely carriers of bushmeat and specific days with a dedicated focus on the bushmeat issue are essential to help curb the problem. A study by Bair-Brake et al (2013) showed that four to seven times more bushmeat was found during a one month period of enhanced surveillance in U.S. Ports of Entry.

4. Increased Resources for Airports (staffing)
Searches take both effort and time; when making a confiscation, customs agents must thoroughly search multiple bags, request information from passengers as to the region of origin and nature of the smuggled products, enter items into a database, and fill out paperwork for those passengers who incur fines or prosecution. Increased staffing may be necessary for agents to more effectively search for and record bushmeat confiscations.

5. Detection dog program for bushmeat at the border with dogs specifically trained to detect bushmeat
'Sniffer' dogs or detection dogs trained in illegal drug detection are already in place in most major airports. The use of dogs in detecting scents is intuitive; dogs can be trained to detect a variety of different scents, including wildlife (USDA 2004; Rolland et al 2006; Wasser 2008; Wasser et al 2009; Vynne 2010; Wasser et al 2012) and a review of their use in wildlife detection is available in Braun (2013). Searching for wild meat is already feasible; a program after the 2001 Foot and Mouth outbreak in the U.K. used 10 dogs to search for illegal meats (UK Bushmeat Working Group 2011). One dog's nose may be more effective in targeting the luggage of offenders than several pairs of human eyes. According to a dog handler for the U.S. Fish and Wildlife Agency based in Louisville, Kentucky, a port where United Parcel Service (UPS) packages arrive, 1 inspector on average can search roughly 75-100 packages per day, while a dog can go through that many packages in minutes, and can search thousands per day (USFAW 2013a, 2013b). The USFAW Agency only recently created a detector dog program to train dogs in the detection of illegal wildlife products (USFAW 2013c; Grace 2013), with 4 dogs in 4 ports where wildlife smuggling is a known problem (Los Angeles, Miami, Chicago, and Lousiville). In contrast, the U.S. Customs and Border Protection Canine Training Program has approximately 1500 dog teams trained to search for narcotics and other contraband smuggling in a number of U.S. ports, and they are known to be highly effective (CBP 2013). The addition of even 1 dog at each airport, trained in the detection of common types of bushmeat, can be an economical alternative to additional staffing and their presence alone can be an effective deterrent to smugglers. One of the responses to this study is a program to train detection dogs to target wildlife products on the Swiss border (Humbel 2013). In 2014, 3 dogs had completed training and will be used in searches (Bütler 2014; van Beek 2014). This is a promising start and the effectiveness of the detection dog program should be monitored and ultimately continued if proven effective in finding bushmeat, with more dogs added as necessary.

6. Incentives for customs agents/airport personnel for finding bushmeat
The focus of the agencies which guard ports tends to be on high profile types of smuggling or those types of smuggling which generate revenue and environmental crimes tend to be a lower priority. Priorities for customs agents include finding drugs, arms, and other contraband items, such as tobacco and counterfeit goods, which earn hefty fees for Switzerland, and for which incentives may be in place for finding these items. In contrast, bushmeat is often a distasteful item to discover, the odor of which can linger for hours, and for which adequate fines and *incentive programs* are not in place. In addition, if bushmeat smuggling was considered a criminal act, this would also provide stronger incentive to capture offenders.

7. Standardization of Customs Data Collection
Information from records of meat confiscations at Flughafen Zürich and Genève Aéroport was provided for this study by the Swiss Customs Administration and allowed us to more accurately estimate the amount of bushmeat being illegally smuggled into Switzerland. It must be noted that *standardization* of these seizure databases, in particular the description of meat and meat products, and most critically, the description of bushmeat/wild meat products, will allow them to be used more effectively by Customs or

others to quantify and qualify bushmeat smuggling. Because many confiscations are described using a generic 'meat' label in the database, it is likely that the number of confiscations which included wild meats were underestimated. Even when meat was recognized by customs agents as suspected bushmeat, species was rarely noted, and the confiscation was most often given a generic one word 'bushmeat' descriptive in the database. Customs records are not typically open to the public or scientists, but can be very useful to gain insight into the problem of illegal meat smuggling, and standardized descriptions for suspected bushmeat, as well as other types of meat confiscations, would allow for more rapid and accurate examination of the records. Detailed files and photos of bushmeat confiscations in particular would result in more precise analyses of the data.

III. COOPERATION BETWEEN ALL PARTIES IN REGARD TO BUSHMEAT SMUGGLING

Trafficking of Bushmeat – A Global Problem

The globalization of goods and services, facilitated by ease of transport via planes and other methods of global movement (i.e. cargo ships, trains, mail, etc.) has changed the way the world economy moves, including the trafficking of wildlife. Ease of communication via the internet, a growing and anonymous portal for the transfer of goods, exacerbates the problem and results in the online sale of many types of wildlife products (IFAW 2005), including live animals, animal parts for use in traditional medicines or fashion, and ***'exotic' or wild meat***, the focus of this study. The volume of internet traffic makes monitoring difficult and allows people to make contact and arrange illegal animal sales with ease. This global trafficking of wildlife products is one of the most serious concerns in the conservation of wildlife today. Not only does it deplete animal populations *in situ*, some to the point of no return, but it also introduces new diseases from these species to previously unaffected global regions, or allows their introduction to a region as invasive species.

As human populations increase, the demand for a product may also be on the increase. In the case of animals with known declining populations in the wild, the implications are clear. In today's world of global movement, bushmeat consumption is no longer feasible, especially in the case of species which do not have a worldwide range. While the volume of bushmeat exports vs. the amounts eaten inside source countries is not known, the illegal trade in bushmeat is most likely to be on the increase due to high profits margins and low costs for smugglers. The *international* demand for wild meat may add an unsustainable burden on some animal populations, exceeding supply, and potentially making the trafficking of wild meat on an international scale one of the highest concerns in the conservation of species. While the consumption of bushmeat inside Africa may provide sustenance for indigenous people living in poverty close to forests, the consumption of this meat on a global scale is unthinkable.

Bushmeat Arriving in European Airports

The problem of bushmeat in Swiss airports is not isolated, but rather relevant to most major airports in Europe and also worldwide. In comparison to other major European airports, such as Paris, London and Frankfurt, Zürich and Geneva airports are relatively small (Swiss Federal Office for Civil Aviation 2012). Outside of our study, however, only the Chaber (2010) study has attempted to estimate the proportion of overall confiscated meats from wild species arriving in an international airport, and for only one country (France). The simple methodologies in this study could be applied to any country with a major international airport, allowing a more accurate picture of the global trade in wild meat. Data from other airports within Europe would allow for a better comparison, both within Europe, and worldwide. With more information about species and quantities, steps can be taken to more adequately control bushmeat smuggling. Assistance from NGOS/scientists, such as occurred in this study, can help to record

and analyze the necessary data and cooperation between border agencies, veterinary authorities, and political systems within Europe is the key to controlling the problem.

Cooperation with Africa – An Important Step in a Global Problem

The problem of bushmeat smuggling is a global problem. Therefore, the solution must also be global. This means not just stopping bushmeat from being imported into Switzerland, but also in addressing the issues where bushmeat is *exported*. In Switzerland, hunting of wildlife is strongly regulated and animal populations are monitored to assure that the amount harvested does not threaten a population's survival. Inside Africa, protection in source countries is often sporadic or non-existent; local and national laws which protect vulnerable animal populations are often not enforced by local police or military. Recent surveys by WCS Nigeria of bushmeat markets in South-eastern Nigeria found that protected and/or endangered species were openly sold in all markets surveyed (Bassey 2010; Nkonyu 2014), including endangered great apes (The Cross-River Gorilla, *Gorilla gorilla diehli*, and the Nigeria-Cameroon chimpanzee, *Pan troglodytes ellioti*), other endangered primates (the Drill monkey, *Mandrillus leucophaeus*, and *Cercopithecus* spp.), forest elephants (*Loxodonta cyclotis*), pangolins (*Manis* spp.), and other protected species. This is unfortunately the case in most African markets and this lack of enforcement of laws, coupled with high profits for poachers and traders, and sometimes corruption of high officials as well, curtails the effectiveness of protective measures for species. In regions where markets are monitored because of active involvement in the problem by local conservation NGOs or law enforcement, the problem of sales of endangered and threatened species does not stop, but only goes underground, creating black markets.

In Africa, the problem of bushmeat is multi-faceted; growing human populations are impoverished and lack jobs. Energy sources and unreliable, and therefore refrigeration is also unreliable, and meat processing and preservation techniques are also limited. Unlike other regions where bushmeat originates, such as South America and East Africa, there is no culture of farming in West/Central Africa, and traditional methods to grow food crops use slash-and-burn agricultural techniques (Oates 1999) - a method that involves farming a plot of land by first cutting down all large trees, and then burning these trees/brush to clear and fertilize the land for planting crops such as banana and cassava, a practice that destroys some 130.000 km^2 of humid tropical forests annually (Palm et al 2005). Plantation crops such as cocoa and oil palm also contribute to loss of natural forests and commercial and illegal logging practices in place in the West/Central Africa region also play a role in the bushmeat trade by opening roads into previously undisturbed forest areas and providing ease of transport for meats on logging trucks (Rose et al 2003; Peterson and Ammann 2004).

Human populations have traditionally relied on hunting wildlife for protein, especially when alternative protein sources are not readily available, and studies estimate that up to 90% of total animal protein consumed in West/Central Africa may still be derived from wild meats (Ntiamoa-Baidu 1997; Davies 2002; Fa et al 2002, 2003; Cowlishaw et al 2004). Fresh local meat from the forest can be an important contributor to protein needs and food security for poverty-stricken, rural communities where alternative protein sources remain largely unavailable (Ntiamoa-Baidu 1997; Mainka 2002; Fa et al 2003; Cowlishaw et al 2004; van Vliet et al 2008). However, West and Central African regions are concurrently being impacted by growing human populations, and there are direct and indirect links between bushmeat consumption and increasing human populations (Brashares 2001; Barnes 2002; Fa et al 2003; Fa et al 2006). In the case of bushmeat, when profits for selling bushmeat are high, it becomes less likely to be consumed by impoverished local residents, but rather becomes a source of profits, from which other goods, including less expensive protein sources, can be purchased. For example, Africa purchases a volume of meats from Europe that are less desirable to Europeans, including low-grade 'stockfish'

from Nordic regions and chicken parts from Germany (Watson and Brashares 2004; Nasi and Brown 2008; Hilse 2014).

All of these issues result in the practice of eating bushmeat being a perilous one that threatens species survival, especially for those species found in the forested regions of West and Central Africa. The international transport of these species to developed countries in Europe and the U.S. for consumption is an additional stressor on animal populations already heavily hunted locally. The failure of African countries to regulate traffic of wildlife *inside* their country, coupled with a demand for an animal *outside* its particular range by consumers in developed world countries like Switzerland, which also may not adequately protect these species upon entry, results in bushmeat being smuggled out of Africa, often quite easily. An increasing number of expatriates in Europe contribute to the demand for wild meats (Mbotiji 2002), as do developed world consumers buying 'exotic' meats for novelty. High profit margins for bushmeat in the developed world become an incentive for organized criminals to traffic in wild meats, assuring that the international transport of bushmeat will continue unless stricter regulations are put in place.

Political Cooperation with Africa:

A dialogue between International conservation and government organizations in Switzerland and those in Africa is necessary in order to more effectively control the illegal trade of bushmeat. This includes, but is not limited to, political cooperation to address issues impacting the movement of species, issues that impact food security, and finally, issues of species conservation. It is important to address the problem of bushmeat both *in situ* and *ex situ*. Conservation and government organizations in the developed world have a wealth of knowledge in regard to species conservation. This collective knowledge must be used to help African governments in regulating the problem. It can also be used to train local conservationists in methodologies which can help to protect wildlife. The following issues are some which need to be addressed cooperatively;

1. Cooperation between Governments and Other Organizations: Cooperation between African governments and organizations with those in developed world countries (i.e. CITES, animal conservation NGOs, etc.) to review and revise those policies which address protection of species and bushmeat exports/imports.

2. CITES Regulations and Paperwork: More effective monitoring and enforcement of existing CITES member regulations/paperwork, especially those from less developed countries with a known problem in regard to bushmeat smuggling. An overseer in CITES international to monitor the volume of paperwork may be a necessary addition.

3. CITES Investigative Group: The addition of an investigation group to CITES to detect fraudulent acts involving CITES regulations and wildlife would monitor and discourage violations. Currently, an infringement within a member country is investigated by that country - in the case of corruption within a country, the problem may be denied or ineffectively managed.

4. Training Programs in Africa for Customs: Cooperation between Customs agencies in Africa and in the developed world can be helpful; for example, in Switzerland, Swiss Customs agents hosted a Gapin (World Customs Organization) training program in Zürich Flughafen where Customs staff from 7 African countries learned about methods of illegal wildlife smuggling (SDA 2012a, 2012b; TeleTop 2012). These types of programs could also be carried out in African airports to better train customs agents in controlling the problem at *ports of exit* in Africa.

5. Law Enforcement Assistance: The development of law enforcement strategies, especially in regard to hunting laws, regulations, and policies inside Africa that will more effectively protect species are important. More effective protection of forest habitat and species through the use of eco-guards, camera traps, and other monitoring strategies may also be important.

6. Training Programs in Africa to help Conservation Oriented Programs: Training programs which impart knowledge of sophisticated conservation methodologies to local talent in Africa, and educational programs that will instill a conservation ethic in local people, are invaluable in changing the mindset and skill level of local conservationists.

7. Development of Alternative Protein Sources: The development of alternative protein sources; i.e. the farming of indigenous species (i.e. cane rats/snails) or of appropriate domestic species, such as goats and chickens, to alleviate dependence on wild meats is a necessity.

8. Improved Food Security: Improvements in agricultural methods that are more effective in food production and energy sources that are more efficient in preservation will decrease dependence on fresh meat from the forest.

IV. FURTHER STUDY OF THE BUSHMEAT TRADE BY CONSERVATIONISTS

Further Study of the Bushmeat Issue inside Africa

Further study of the bushmeat problem inside Africa can provide important information about the international trade in this meat. While efforts to bring disparate information about the bushmeat industry together can be found in the literature, information from these studies is fragmented. Details of bushmeat consumption in one region may not be relevant to another. Studies also show a lack of standardization in the quantitative measurement of bushmeat, making comparisons difficult, although comparison should be the goal (Wilkie and Carpenter 1999; Bowen-Jones 1999; Fa and Peres 2001; Bowen-Jones et al 2002; Fa et al 2002; Milner-Gulland et al 2003; Fa et al 2006; Brashares 2011; Nasi et al 2011). Methods to study the bushmeat trade in Africa which standardize the measurement of bushmeat, and which also address the quantity being exported out of Africa, are a necessity. A focus on exports to Europe and other developed world countries, including those up and coming Asian countries which are seeing a boom in their economies, would help to describe the bigger picture of bushmeat smuggling. Understanding trends in wild meat consumption are one of the keys to stopping it.

Species representation is not yet complete in the DNA gene databanks; enough samples must be collected from all regions where a species occurs in order to represent the genetic diversity present in that species. In the case of some highly studied species, this has already been accomplished, but for many species, there is not enough interest or funding for such sampling. The collection of DNA samples from species indigenous to West/Central African countries is important, including the various species and subspecies of the *Cercopithecidae* which are found frequently in the bushmeat trade, as well as other rare and endangered West and Central African primates. Also important is DNA from all species of African pangolins, and for some West/Central African duiker species and other ungulates found in forests in this region. With a large enough sample size of individuals, regional differences in populations can also be identified, as species considered endangered in one region or country may not be in another. Non-invasive sampling is important to animal welfare, and therefore collection of hair or tissue from bushmeat markets in Africa may be possible. The collection of samples for those species at high

risk from the trade and currently underrepresented in gene databanks would allow for more accurate species identifications and subsequent criminal prosecutions of cases involving illegal animal meat smuggling.

Further Study in Switzerland

In order to more completely address the issue of bushmeat smuggling, further study of the problem in Switzerland may also be necessary. We are currently cooperating with the University of Bern to create a more sophisticated model of bushmeat smuggling for Switzerland; sample sizes for control days were small, and a larger sample size, randomly collected from all meats over the year, would more accurately determine the proportion of illegally smuggled meats that are bushmeat and identify all species at risk from the trade. Information from the Spiez Laboratory (Swiss Federal Institute for NBC-Protection) about potential health hazards present in our bushmeat samples should also be disseminated to interested parties. The collection of a larger sample size of fresh bushmeat may be necessary to fully address the level of health threat posed by bushmeat. As mentioned above, cooperative programs between Switzerland and African countries would be a helpful step in addressing the issue of bushmeat smuggling. Training programs between Swiss and African Customs Agencies, such as those that took place at Flughafen Zürich (SDA 2012a, 2012b), would allow for the transfer of necessary knowledge to African Customs Agencies and would result in more effective control of the illegal export of species *before* the problem arrives on Swiss soil.

Finally, the participation of Conservation NGOS, Universities, and Governments agencies together, such as was accomplished in this study, allows for a much broader perspective on all the issues involved. It is certain that this study will play a role in increasing awareness about bushmeat smuggling in Switzerland, and in other developed world countries worldwide. It is hoped that it will also play a role in inspiring other countries to address the issues described here within their own infrastructures, and by doing so, better protect those species vulnerable to the international trade in wild and exotic meat.

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