Uncovering Patterns of Public Perceptions Towards Biodiversity Crime Using Conservation Culturomics

Andreas Y Troumbis (atro@aegean.gr)

University of the Aegean School of the Environment: Panepistemio Aigaiou Schole Periballontos https://orcid.org/0000-0003-3884-9141

Spyridon Iosifidis

University of the Aegean School of the Environment: Panepistemio Aigaiou Schole Periballontos

Christos Kalloniatis

University of the Aegean School of Social Sciences: Panepistemio Aigaiou Schole Koinonikon Epistemon

Research Article

Keywords: Biodiversity crime, conservation culturomics, conceptual construction of crime culturome

Posted Date: September 27th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-770642/v1

Abstract

This paper examines aspects of the relationship between (1) the recently typified form of biodiversity crime, (2) information made available to the public through the Internet, and (3) cultural dynamics quantified through info-surveillance methods through Culturomics techniques. Two conceptual models are proposed: (1) the building-up process of a biodiversity crime culturome, in a language, and (2) a multi-stage biodiversity conservation chain and biodiversity-crime activities relating to each stage. Crowd search volumes on the Internet on biodiversity crime-related terms and topics are used as proxies for the public's interest measurement. The main findings are: (1) the concept of biodiversity-crime per se is still immature and presents low penetration to the general public; (2) biodiversity-crime issues, which are not recognized as such, are amalgamated in conservation-oriented websites and pages; and (3) differences in perceptions and priorities between general vs. 'niche' public with particular interest(s) in environmental issues- are discernable.

1. Introduction

The *Convention on Biological Diversity* (Rio de Janeiro 1992) is the epitome of liberal conservation strategy, a compromise between the designation of Protected Areas (PAs *hereafter*), re-regulation of the environment, and commodification of biotic resources (Secretariat CBD 2005). Real-world results in implementing this conservation strategy are relatively weak (e.g., Butchart et al. 2010; Perrings et al. 2010; Tittensor et al. 2014; Blicharska et al. 2016; Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) 2019; XXXX 2021). Research on the so-called biodiversity conservation 'implementation gap or space' (e.g., Maas et al. 2019), i.e., disciplinary and geographical biases and limited communication between scientists, practitioners, and decision-makers, is actively developing. Overall, there are *ca* 450 papers cataloged in the *Web of Knowledge/ Science (*WoK/S *hereafter)* as of July 2021 responding to the search string "conservation AND implementation AND gap AND biodiversity"; and >145,000 papers tagged with the term "biodiversity" are listed in WoK/S, during 1987–2021). The academic effort repeatedly highlights the divergent directions of (1) political commitments, Conventional and legal framework (> 700 International Agreements and domestic conservation accords, e.g., Chester and Moomaw 2008) and (2) capacity building, awareness campaigns, or funding (hundreds of International/local ENGOs and billions of US$ or € invested, e.g., Fulton and Vercammen 2014; EU/Neemo/Ernst&Young 2016) versus the meager advances in the field. Several causes, ranging from opportunism in protected areas designation (e.g., Meir et al. 2004) to administrative incapacities and institutional weaknesses (e.g., Mascia and Pailler 2011), to reduced public participation in decision-making (e.g., Irvin and Stansbury 2004), have been proposed for this ineffectiveness, i.e., the measure of 'true' conservation achievement per cost (e.g., Arponen et al. 2010). Environmental and biodiversity crime is gaining currency in the interdisciplinary study of human-nature interactions as a proximate cause of threat to biodiversity conservation (e.g., Rose 2011; Sundstrom 2016; Elliott 2017; Moreto 2017). Biodiversity crime is considered as a specific class of pressure(s) upon (1) biological entities, i.e., genes, individuals, and populations of species and their habitats; (2) the ecosystem functions and services they support and generate; and (3) conservation policies of communities, societies, or States (e.g., Hoggt and Carrington 1998).

As a criminological issue per se, the sparse biodiversity-crime literature attempts to integrate narrative and normative (e.g., Biber 2017), legal and statutory (e.g., Apel 2013), sociological (e.g., Kavish and Boutwell 2018), or economic (e.g., Lacey et al. 2018; Pogarsky et al. 2018) definitions and explanations of individual and/or syndicate deviations from the commonly adopted norm of social order. The cultural dimension(s) of the multivalent problem of anti-social behavior and unlawful acts (e.g., Eysenck 1996) in the domain of biodiversity conservation is somehow neglected. Biodiversity crime, situated at the interface of multiple disciplines, including common Law (e.g., Zhu 2014; Do Vale 2015), environmental and green criminology (e.g., Tosun 2012; Beirne et al. 2018; Rodriguez Goyes and Sollund 2018; Brisman and South 2019; Brisman 2020), economics (e.g., Le Gallic 2008; Lynch et al. 2017), sociology (e.g., Huebschle 2017) and conservation science (e.g., Cafaro 2015; Solomon et al. 2015; Maas et al. 2019; XXXX and XXXX 2020), presents interesting conceptual and methodological peculiarities. For instance, in terms of ethical judgments, biodiversity crime is often difficult to grasp, for it offends intrinsic and inherent values of nature (e.g., Diaz et al. 2015) that are culturally defined but not ecumenically protected by human Law. The controversial example of circus animals, bullfighting in Hispanic countries, or bear-subduing in the Balkans, until some

decades ago, generated the popular legend of tamers and are (or were) considered a cultural event, heritage, or entertainment attraction. What differentiates bullfighting and bear-subduing is that the latter is listed as an endangered species and not the mistreatment per se of both animals. What makes the difference between the illegal trade of a lion vs. its exposition in a zoo is the existence of an incumbent scientific discourse considering the latter as conservation-positive. It is not a straightforward task for the average citizen, who is a carrier of unclear value systems (e.g., Pascual et al. 2017) and is exposed to complex scientific and legal discourses to assess criminal harms and damages caused to biological beings that are generated by the accumulative deterioration of their biotopes or the illicit appropriation of scarce biotic resources. Harms and damages that are not immediately visible, often 'victimless' (Cardwell et al. 2011) and certainly 'voiceless' (Solomon et al. 2015).

According to Europol, the European Union's Law enforcement Agency, environmental and biodiversity crime intensifies, especially during the Covid-19 circumstances (Europol/SOCTA 2021). Partial causes of biodiversity-crime dynamics might be identified in recent environmental and criminological literature (e.g., Brisman 2020). At first, one could note the likely lack of substantial public interest in conservation issues (e.g., Novacek 2008; Mccallum and Bury 2013; Ficetola 2013; Nghiem et al. 2016; Burivalova et al. 2018; XXXX 2017a,b; 2019). Second, the cultural variations and linguistic differences in people's perceptions of nature (e.g., Funk and Rusowsky 2014; Roll et al. 2016; XXXX 2021) often estranges them when coupled with scientific terminology and conservation concepts (e.g., Fischer and Young 2007). Third, the mismatches between scientific effort and conservation needs (Fisher et al. 2010). Fourth, the weak correspondence between biodiversity crime ontologies and legal typification, as in the case of ordinary crime (e.g., Brantingham 2016), might make it challenging to integrate into the penal system, the prosecution procedures, and its fuzzily functioning green benches. Fifth, the inefficiency in international cooperation is an additional cause for navigating the conservation implementation space unsuccessfully (e.g., Rose 2011; Elliott 2017; XXXX and XXXX 2020). As Elliott (2017) eloquently stated, the complexity per se of the conventional international framework on environmental and biodiversity crime leads to legal indeterminacy, normative ambiguity, and regulatory uncertainty.

However, although a vital component of cultural human-nature interactions, the repercussions of such indirect drivers upon the public interest in biodiversity crime issues have not yet been studied or remain partially unexploited, to our best knowledge. Understanding people's perceptions, awareness, and interest in the benefits and costs of biodiversity crime are of primary importance for determining whether crime-combatting policies will succeed to curve it in the long term. We hypothesize that this challenge might be approached methodologically through the emergent *Culturomics* epistemology (Michel et al. 2011), i.e., the quantitative investigation of cultural trends through the automated linguistic and lexicographic analysis of millions of digitized books (*ca* 16 M as of the end of 2019; data available through *Google Books Ngrams Viewer* service). Michel et al. (2011) made further the point that "*culturomics extends the boundaries of rigorous quantitative inquiry to a wide array of new phenomena spanning the social sciences and the humanities*" (p. 176). Further, *Conservation Culturomics* (CC henceforth) is an epistemology *per se* that seeks to understand the evolution of human-nature relationship(s) through discursive expressions that define human acts and behavior (e.g., Ladle et al. 2016, p. 269; Sutherland et al. 2018; XXXX and XXXX 2020).

We will utilize data from *Google* crowd searches on biodiversity crime-related words and topics to uncover patterns of perceptions across time, possible behavioral change over time, and pinpoint drivers of the public's behavioral uptake. This approach might complement the fragmentary yet use of big online data (Web, mass media, social media), although they represent a rich opportunity to investigate public perceptions on emerging topics such as conservation and biodiversity (e.g., Correia et al. 2016; Correia et al. 2017; XXXX 2017; Toivonen et al. 2019). We expect that bridging this gap could be of great importance for improving the efficacy and success of conservation and biodiversity crime prosecution in the long term.

In this paper, we attempt (1) to define a biodiversity-crime 'culturome', i.e., a linguistic set of words, terms, or topics that encapsulate its various meanings, aspects, and domains at the reach of people (Sect. 2.1); (2) to explore general trends of public interest in biodiversity crime themes using *Google Trends*-crowd search data as a well-established technique of CC (Sect. 2.2. and 3); (3) to propose a hierarchical ontology of acts that could be considered as biodiversity crimes (Sect. 4); and (4) to discuss ontological correspondences between modern forms of crime (Sect. 4).

2. Methodological Issues: Setting The Scene

We base our overall approach upon two conceptual models. These models serve as explanatory bases for constructing a specialized pool of associated terms (or phrases) on biodiversity criminal issues addressable through conservation culturomics epistemology. The first model introduces a mechanism explaining the assembly of words or terms in the kernel lexicon of a language encapsulating the biodiversity crime phenomenon. The second model introduces a typified form of the conservation implementation chain and its sequential stages governing biodiversity components and conservation policy conditions against which criminal activities and acts are perpetrated. The CC methodology is expected to help understand how initial public interest – or curiosity - expressed through crowd searches on the Internet might reflect sustained public adherence to biodiversity crime importance; and, therefore, to be investigated as a significant component- into the overall biodiversity-conservation strategy implementation, in the future.

2.1.Conceptual model 1: a mechanism for the public construction of biodiversity crime culturome.

Petersen et al. (2012) qualify a language as an 'ecosystem of words' that is permeable to other languages; they further distinguish time scales in its evolution. One can identify three primary sources of words (terms) –and phrases- relating to biodiversity crime issues: (1) the "kernel" lexicon consisting of words emanating from scientific vocabulary and more frequently used words; (2) the "unlimited" lexicon comprising terms and phrases commonly used in "public" communication channels, e.g., mass media, social media and, most importantly, vernacular names or expressions of biodiversity entities; and, (3) "exotic" terms to the reference language, incoming from other languages. Altogether, they form a pool of words (terms) focusing on this specific issue. The public, i.e., the Internet users, searches massively for information on a subset of this pool: it is a sampling process from which a culturome is constructed after the systematic association of terms in large volumes of crowd searches. In direct analogy to the concepts of 'gene' and 'Genomics', individual words, i.e., terms conveying a concept, are discrete inherited units of a language. Linguistics refers to the study of etymology and expressive evolution of terms in a language's lexicon. In contrast, besides its neological character, culturomics aims to develop computational lexicography to investigate cultural phenomena by analyzing digitized texts and data mining on the Internet (Michel et al. 2011).

Specialized Internet services provide sets of associated terms (e.g., *Google Adwords Tool, Wordstream Free Keywords Tool, Keywords Everywhere*). Such associations present trend lines of crowd search volumes and altogether form evolving culturomes with a series of properties (Fig. 1). Two issues are calling for caution in this mechanism. First, several scientific terms correspond to broader topics, e.g., climate change, global warming, greenhouse gases and effects, *et cetera*. Second, although vernacular names of species are essential components of a culturome and eventually semantically identical in the public's mindscape regarding their scientific names (e.g., Correia et al. 2016; Jarić et al. 2019), they might hide taxonomic differentiations: e.g., the African elephant corresponds to two species, *Loxodonta africana*, and *Loxodonta cyclotis*.

Terms are connected to specific segments of the conservation implementation chain (see Conceptual model, Sect. 2.2. here below). Some of them contribute conceptual emphasis: e.g., biodiversity, ecosystem, species, or conservation. Others are complementary within the same segment: e.g., scientific and vernacular names of species; others complement segments: e.g., PAs vs. EU Natura 2000 conservation sites.

2.2. Conceptual model 2: the conservation implementation chain, gaps and crime.

This simplified linear conceptual model depicts a 5-stage ideal implementation process for conservation policy presented in Fig. 2. Stages are identified as science, rhetoric, gazettement or institutionalization, policy instrument building and confirmation. The model includes dominant processes per stage, actors and major drivers as well. The science stage corresponds to the identification of biodiversity "objects" such as species or habitats. Rhetoric is the stage where social processes of argument construction in favor of biodiversity conservation occur; scholars or Environmental NGO experts are the main actors who establish the basis of biodiversity conservation needs through a cognitive process. If science and rhetoric are efficiently combined, then decisions on gazettement (or institutionalization) are taken through political processes; there is a

shift in dominance from actors to drivers since the economy or national sovereignty issues play a core role in shaping the procedure. Technology and technocratic knowledge dominate and drive the stage of policy instruments building; decisions on spatial planning or selection of sites to be protected or organizational structures and functions of governance systems are key issues at this stage. Finally, confirmation is the stage of action on the ground; specific management plans should be drafted, personnel should be authorized and hired, budget and cashflows secured, *et cetera*. One might expect that several feedbacks among constituent stages of the implementation chain that speed it up or slow it down in actual conditions might exist. If the implementation process fails or does not perform efficiently, there should be 'cracks' or 'chasms' between the stages (Fig. 2). For instance, there might be inefficient communication of scientific knowledge and message, the Sc-Rh crack; or, resistances in transboundary agreements, collaboration and coordination, the Rh-Gz crack; or, difficulties and lack of political and administrative will to confirm in the ground the previous stages, the Gz-Plb crack; or, capacity building issues, the Plb-Con crack; or, most likely some combination of all these conditions.

Biodiversity crime actions or activities (examples) are mirrored into each stage. Each one might affect components of a particular stage or, most importantly, it might energize the 'cracks' that block the sequence of the conservation implementation process.

2.3. Conservation Culturomics and biodiversity crime

Ladle et al. (2016, p. 269) established a 5-axes epistemic program of Conservation Culturomics. A conceptual translation or correspondence of this program into non-compliance conservation concepts, i.e., biodiversity crime, is attempted or summarized in Table 1. This attempted correspondence might have various connotations, from recognition –and valuation- of crime activities *per se* to educative schemes against criminal activities.

Table 1
A potential scheme on conceptual relationship between Conservation Culturomics epistemic program/agenda and environmental/biodiversity crime. The five horizontal fields reflect the core epistemology of Conservation Culturomics as defined by Ladle et al. 2016. The complementary annotations on Culturomics fields describe actual relationships with conservation discourse and actors involved in biodiversity crime, either positively or negatively.

Conservation Culturomics **Program** **(Ladle et al. 2016)**	**Conservation significance**	**Biodiversity crime actors/ players (examples)**
Recognizing conservation-oriented constituencies and demonstrating public interest in nature	Creation of Internet/Social Media communities, identification of Conservation adepts, NGOs militants, political supporters and thinkers, environmental-friendly citizens, …	Hunters' Associations, Rangers, Forestry Department Officials, NGOs activists, media reporters, …
Identifying conservation emblems	Protection of keystone -species, species with wide-range territories and/or historical/ cultural symbolism	Species with appeal in common public/media discourse: elephant, tiger, rhino, monk seal, endemics, ethno-diversity species, …
Providing new metrics and tools for near-real-time environmental monitoring and to support conservation decision making	Complementary but no-substitutive information on public opinion evolving at various time scales and cultural entities	Analyses of biodiversity crime approximate information through Internet-based crowd search services, such as *Google Trends, Adwords, N-gram viewer, Wikipedia, Twitter, FB, …*
Assessing the cultural impact of conservation interventions	Role of culture-driven human-biodiversity relationship in terms of appropriation of biotic/ ecosystemic resources	Regional/local (mostly) economy platforms relating to primary, secondary and tertiary production (e.g. green/biological agriculture, circular economy, low carbon industry), etc.
Framing conservation issues and promoting public understanding	Environmental education, awareness and information activities…	Typical and a-typical activities within environment-related groups such as scouts, school pupils, outdoor activities associations, tourism promoters, …

2.4. Worldwide trends of public interest in biodiversity crime

In order to approximate public interest in biodiversity crime issues, we accessed Internet crowd-search activity (specifically through *Google* search engine and *Google Trends* service, *GTs* hereafter) from January 1, 2004 to August 31, 2020. We targeted explicitly (1) *collections of animal species*, under both their vernacular/popular names and scientific names, in most cases; this information was meant to trace the evolution of public interest in species that the International Union for Conservation of Nature (IUCN) lists as vulnerable, threatened, endangered, or critically endangered. The status of such listed species is highly related to various forms of biodiversity-crime types. Notice that the two collections do not match exactly since the 'vernacular' sub-group emphasizes on the popularity of species (e.g., Correia et al. 2016). Interestingly, 80% of queried species returned consistent time series. (2) The *biodiversity crime-related pool of terms*; we queried *GTs* service for > 150 terms and/or phrases search strings, of which just 30 crime-related crowd-searched terms and phrases (*ca* 20% of a hypothetical unlimited lexicon, in the sense of Petersen et al. 2012) returned consistent time-series. The selection of searched terms obeys two criteria: (i) terms are addressing the five ideal stages of the conservation implementation process, i.e., science – rhetoric – institutionalization - capacity-building - policy confirmation; (ii) terms are selected to serve as broad conceptual generalizations/stage, albeit occasionally overlapping in meaning. (3) The *identification of web pages* dedicated to themes and issues (1) and (2) here above; we contrasted these findings to the number of relative publications in the *WoK/S*, during the same period. The most significant observation is the low specialization of web pages since many of them refer to multiple biodiversity-crime types and conservation implementation issues.

All search strings are in English; therefore, the information collected is coarse-grained from a Culturomics perspective. Results presented hereafter are bound to a worldwide vocabulary that sidesteps linguistic, cultural, societal, and technological variations (e.g., Funk and Rusowsky 2014; XXXX 2019). In other words, we used no geographical and linguistic restrictions when investigating *GTs*, so our data strictly reflect worldwide results from those users searching the Internet with *Google* in English (see Conclusions section for further details).

3. Results

Four configurations of *GTs* analyses are provided hereafter:

(1). Figure 3 presents the ordination in a 2D slope (x-axis) – r^2 (y-axis) plane of the two collections of species: (a) popular species after their vernacular name; (b) species after their scientific names. It is assumed that this comparison signalizes differences in public interest between the general public and some "niche" public, which most likely represents scientists, officials of Non-Governmental Environmental Organizations, members of various animal-watching groups, and zoophilic charities, *et cetera*. In our terminology (see Sect. 2.1 here above), the culturomes constructed after vernacular/popular and the scientific names ordinated in the slope/r^2 plane present a U-shape distribution. We suggest that a 2nd-degree polynomial or parabola might approach such a U- slope/r^2 curve; and that the coefficients *a, b, c* of the corresponding $f(GT) = aGT^2 + bGT + c$ equations have specific physical meaning that might be used in comparing these culturomes. For instance, *a* coefficient controls the curvature of the parabola, with higher values of *a* indicating stronger internal coherence of the culturome. The *b* coefficient in combination with *a* in the form $x = -\frac{b}{2a}$ indicates the x-ordinate of the U-curve (the slope component). Moreover, *c* coefficient indicates the y-ordinate (the r^2 component); higher *c* indicates increased linearity of GTs of constituent terms.

(2). Figure 4 presents linear vs. cyclical trends of public interest in the two collections of species nomenclature. In both cases, the predictor of individual term results was time, and the response variable was search-volume/term as expressed by corresponding GTs. The deviation of *ca* 38 [r^2 linear vs r^2polynomial] points from the 1:1 diagonal in the corresponding plane shows that the overall public interest in species under pressure from biodiversity crime-related activities follows time cycles analogous to the core concept of biodiversity (XXXX 2017b). This graphical representation complements results presented in Fig. 3: 'niche' public seems more reactive to variations in crime pressures upon conservation flag species.

(3) Fig. 5 presents normalized GTs crowd-search data to identify –mostly- long-term linear evolution of the global public interest in the selected topics of the conservation implementation chain during 1/2004-8/2020. This configuration is typical of early publications in Conservation culturomics (e.g., Mccallum and Bury 2013; Ficetola 2013; Proulx et al. 2013; Wilde and Pope 2013). The merits and flaws of such approach are discussed in XXXX and XXXX (2020).

(4) Fig. 6 [A, B, C] presents a synthesis of long term evolution of an ensemble of *ca* 30 biodiversity crime-related concepts available in two different media environments: (1) scientific publications cataloged in *WoK/S*, 'the scholar pool of knowledge'; and, (2) number of web pages, 'the public pool of knowledge', dedicated to the same issues. The search period extends from January 1, 1990, to August 31, 2020. The starting date was determined after almost all core environmental meta-concepts, i.e., biodiversity, sustainability, and planetary change were constructed, in the late '80s. 'Poaching' is the term attracting most interest in academic literature; 'wildfire forest arson(s)', a criminal activity, is by far the phrase repeatedly appearing in environmental/biodiversity oriented web pages.

4. Discussion

The discussion extends into three directions based on the findings here above. The first direction relates to drivers of biodiversity crime and its situation into a framework of social-ecological systems under exogenous vs. endogenous pressures. Within the incumbent conceptual framework of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (Diaz et al. 2015), core literature proposes long series of higher-order multiple and interdependent causes of- and effects upon- social-ecological systems that drive the failing implementation of conservation policies. External abrupt shocks or transient pressures upon individuals and their communities' economic and social status are shown to provoke significant endogenous pressures upon the state of biodiversity and ecosystem service provision units (e.g., Roosenvell et al. 2010). Misbehavior against- and misappropriation of- biotic resources have been related to the economic downturn in various biomes and human development conditions (e.g., South East Asia, Dauvergne 1999; Venezuela, Rodriguez 2000; Greece, Lekakis and Kousis 2013; XXXX and XXXX 2020). Further, change of regime (e.g., Robinson and Milner-Gulland 2003), war (e.g., Geist and Lambin 2001; Duffy 2014; Douglas and Alie 2014; Runhovde 2017; Liévano-Latorre et al. 2021), corruption (e.g., Gore et al. 2013), but also culture and religion (e.g., Grainger 1993) and the abrupt penetration of science and technology into local socio-ecological setups (e.g., Lambin et al. 2006) are proposed as disruptive conditions altering the effectiveness of public conservation policy implementation. Recently, the Covid-19 pandemic and global human confinement conditions, including the ban of hunting and fishing, have also been related to ambivalent conservation efficiency issues (e.g., Bates et al. 2020). Such empirical cases are related to various degrees to biodiversity crime, e.g., poaching, illegal logging, and fishing, in the sense of non-compliance to- or voluntary violation of - conservation rules (e.g., Solomon et al. 2015) through mechanisms relating to market distortions and administration incapacities (XXXX and XXXX 2020). Interestingly, similar criminogenic mechanisms have been proposed or predicted to apply during and after the Covid-19 pandemic human confinement, even within protected areas (e.g., Koju et al. 2021).

However, the analysis of the multivalent problem of biodiversity crime should not rely upon episodic or short-term anomalies of social-ecological systems' trajectories. Instead, it should focus on long-term chronic pressures generated by illegal deviations in activities such as endemic and/or endangered species trade -including trophies or biological material collection, uncontrolled wet meat markets, the need for household food appropriation such as the bushmeat case, specialized industry interests -including equipment and services supply, or the operations of organized biodiversity-crime hierarchies. In that perspective, the discussion on biodiversity entrapment into poverty (e.g., Adams et al. 2004; Barrett et al. 2011) and the debate on price-determining vs. price-determined valuation of biodiversity (e.g., Farley 2008) might constitute a guiding analytical framework relating to willingness-to-pay for illegal biological material or misuse of biotopes. This relates to the dominant assumption of Law enforcement authorities that environmental and biodiversity crime is directly linked to the search for illicit profits (e.g., Ayling 2013; Leberatto 2017). Under both conditions, i.e., transient vs. chronic pressures, it seems preferable to adopt a terminology of 'mechanisms enabling' biodiversity crime that allows avoiding the 'blaming of the poor' for biodiversity loss if criminal activities are decoupled from poverty and social justice issues (Lynch et al. 2017).

The second direction of the discussion relates to the need for developing an ontology for biodiversity crime. Such ontology should be conceptually simple to reach, intrigue positively and energize the public interest as to the connections between biodiversity crime and unsuccessful conservation. It should be explicit, allowing for conceptual enrichment in a way that facilitates interdisciplinary collaboration, transnational coordination, and ultimately judge's decision; for it addresses cases that might carry built-in ambiguity in expert terminology and semantics if examined from the perspective of different scientific disciplines. It should also be formal to avoid Courts oscillating for justice between incumbent administrative policies and choices regarding conservation (e.g., Blicharska et al. 2016); theoretical mismatches of general penal and biodiversity crime cases (e.g., Barton and Moran 2013); insufficient prosecution dossiers; insignificant judicial statistics, similar to those in unregistered crime (e.g., Stroh et al. 2016); and, theoretically unprepared benches and district attorneys (e.g., Rose 2011).

Figure 7 presents such an ontology and a typology of biodiversity crime. Classes of biodiversity crime are sets of concrete concepts defined by the Law; for example, a Person or Offender is not necessarily meant in the physical identity of a 'biological individual' but as a 'personification' through that individual of a rigorously defined criminal act. The same stands for the inverse case of the prosecuting law agent. Therefore a Class is a representation of a biodiversity crime concept relating to offense or prosecution. To make operational the proposed ontology, three Classes are necessary.

First, the Class of Malicious_Act lists in some strict way categories of offenses. According to the classification scheme, one Class might be described using a series of first order subClasses arranged in a sub-class/super-class hierarchy. For example, in Fig. 7, the Class Malicious_Act comprises five first order subClasses, i.e., illegal hunting, illegal logging, illegal fishing, trade, and collection. Each first-order subClass is further divided into second order subClasses. Therefore, a 'Person' who destroys nests of a bird species, be it Red-listed or not, is committing an offense of the subClass Collection of the Class Malicious_Act. Where the boundaries of a Class with its subClasses are set is a matter of classification of functionality, rigorousness in the legal definition of acts, and similarity between them. For instance, viewed from the standpoint of conservation biology, the second-order subClass_Prohibited_technique in the subClass Illegal_hunting as a case of the Class Malicious_Act is functionally similar, not to say identical, to the correspondent in the subClass Illegal_fishing; for a poacher might use banned equipment to attract flocks of waterbirds to shoot massively and/or he might use dynamite to collect fishes massively in the same wetland. The only distinction between these acts lies with the relevant Law qualifying the act, the Law on Hunting in the first case and the Law on Fishing in the latter.

The second Class refers to Responsibility. The penal system recognizes two first-order subClasses: objective and subjective responsibility, which are divided into second-order subClasses. Within the subClass Objective_responsibility, the distinction is made between Act, Attempt, and Negligence when a single individual perpetrates the crime. Commission as a second-order subClass involves a third person and is usually treated through prescriptions included in another range of the criminal Law. The Commission might be of critical importance in organized crime cases –a class that is repeatedly observed in the illegal logging/smuggling case where a hierarchy of roles should be judged. Within the subClass Subjective_responsibility, the distinction is made between Intentional and Unintentional crime.

The third Class refers to the actual provisions of the Law, i.e., the Articles that define the specific crime and predict criteria of application and sanctions. It should be noticed that both national and international legal framework governing forests, fisheries, various categories of protected areas and species, land use, and spatial planning predicts hundreds of Articles, clauses, and sub-categories about all probable and improbable situations. It indeed leads to Elliott's (2017) conclusions on legal system mis-performance due to its inherent complexity, indeterminacy, and ambiguity.

The three Classes share a common characteristic; they describe the conditions to be satisfied, so an individual case is assigned to a specific type of biodiversity crime. Therefore, links between classes are necessary; these links are common properties within a given domain of knowledge. A given set of properties characterizes a group of individuals that should be treated equally by the penal system. For example, all hunters who intentionally shot a listed brown bear within a PA pertain in the same group of penal treatment. On the contrary, hunters who shot a wild boar intentionally in the same PA are not, but they might pertain in other Classes and/or subclasses of the same legal framework; for they all committed the crime of hunting

within the PA, but one species is Red-listed, and the other is not. This Class should be further enriched with twin Laws on Hunting and/or Conservation.

The third direction relates to conceptual similarities of biodiversity crime with other modern forms of crime, as typified by Europol (SOCTA 2021). As shown in Table 2, we propose a scheme of correspondence between crime types to which the public is conceptually acquainted and their ontological equivalent in the domain of biodiversity. We assume that such an approach might help overcome the public's limited interest in- and understanding of- the various facets of biodiversity crime, individual responsibility issues, and the mechanics of organization, operation, financing, or money laundering of such criminal activities and networks.

Table 2
Examples of correspondence between modern criminal activities, as typified by Europol (SOCTA 2021), and biodiversity crime.

Criminal activities	Biodiversity crime equivalent	Examples
Genocide	Interspecies genocide	6th mass extinction
Cyber-dependent crime	Intrusion to sites of conservation importance	Hunting in protected areas
Trafficking of human beings	Trafficking of protected species	Violation of CITES Convention
Smuggling of people	Smuggling of biotic resources	Transborder commerce of stolen wood
Waste crimes	The commerce of banned and hazardous substances/materials	Violation of the Vienna Convention and the Montreal Protocol for the ban of ozone-depletion substances
Organized property crime	Trespassing private game refuges	Illegal fishing in aquaculture installations
Trade in illegal firearms and explosives	Hunting and fishing gear and equipment	Fishing with dynamite and banned nets

5. Conclusions

This paper proposes an approach of the relationship between (1) a recently typified form of crime, i.e., biodiversity crime; (2) information made available to the public through alternative media, i.e., the Web, social media, and specialized academic bibliography; and, (3) cultural dynamics quantified through Culturomics surveillance techniques.

Overall, biodiversity crime is at an embryonic stage within the typical penal law types, understanding, and perception(s) of the public (e.g., Brantingham 2016). For example, the classic ‘theft’ culturome, i.e., the set of associated terms *in Google* crowd searches, comprises 511 keywords or the ‘murder’ one, 423 keywords. On the contrary, ‘biodiversity conservation crime’ comprises only 1. It is the word ‘poaching’, a term with a long cultural history and relating more to practices than to crime *per se*, which comprises 286 keywords.

Most precursory conservation culturomics research focuses on public interest trends using Internet-based services that provide data on search volumes for specific keywords - e.g., the *Google Trends* service - or on sets/collections of related keywords - e.g., *Google Adwords Keyword Tool* or the public domain *Wordstream Keyword Tool*. Such research has helped in better understanding both structural (size of search volumes, lexicographic composition and relative frequencies of keywords) and dynamic (trajectories in time) traits of culturomes (XXXX and XXXX 2020) as well as significant determinants of their diversification across cultural, linguistic and technological setups (Funk and Rusowsky, 2014). However, such integrated information cannot address whether punctual interest in a biodiversity-crime-related keyword is sustained in time and, more importantly, whether it evolves towards increased public sensitivity for strategic conservation issues.

Models 1 and 2 have been tested against real-world data on Internet searches in the specific context of biodiversity-crime-related searches in English worldwide (data source: *Google* search volumes provided by *WordStream Keyword Tool*). It is a weakness of our approach since it rules out cross-cultural comparisons. However, it was deemed necessary to adopt such a linguistic sample in order to drop variability and noise generated by cultural, linguistic, chronological/conjectural, social, and technological determinants of the phenomenon (e.g., Rizzolo et al. 2017) because of fuzzy and vague translations of core biodiversity-crime terms provided by web-based services – especially in languages where endangered species are located, and criminal activities eventually occur, e.g., *Panthera tigris tigris* in Bhutan, *Andrias davidianus* in China, *Lemur catta* in Madagascar, or *Varanus komodoensis* in small Indonesian islands.

Segmentation of conceptual searching across the biodiversity conservation implementation chain (Model 2) is arbitrary. However, it represents a well-informed guess on articulating a suite of concepts that expresses rational progress along with conceptual differentiation in the conservation science-policy gradient.

One might hypothesize that several mechanisms interfere with a shadow process of transforming the stochastic process of an individual's interest–e.g., new, additional, or expanded search(es) for associated biodiversity-crime-related keywords – to a somehow deterministic predictable pattern of group-behavior. Such mechanism(s) might be, among others: (1) *search efficiency*: individuals become mentally more confident and spend less time hesitating, learning, or making disappointing mistakes in searching biodiversity-crime related information sources; (2) *replication*: as information and knowledge converge to standardized arguments on biodiversity-crime, efficiency in searches tends to increase; (3) *network-building*: as a keyword is more widespread in information networks, an individual *Google* searcher uses it more efficiently because s/he is familiar with it; (4) an analogy of *software engineering POLA principle* (Principle Of Least Astonishment), i.e., information gathered from didactic sources regarding biodiversity-crime should comply to a discursive manner consistent with how individual users of this information are likely to expect it to behave; that is, average users should not be estranged by complicated terminology and complex explanations (Fischer and Young 2007; Novacek 2008).

Finally, our results support the idea that there might be divergence(s) among culturally determined social perceptions of criminal acts and their effects upon biodiversity and ecosystems, expressed in natural language that may lead to different interpretations of biodiversity crime -and its drivers. The cases of observed differences between the general public and the niche public (U-shape slope/r^2 or the importance of recognition of cyclical trends in public interest) are characteristic, generating likely varying penal evaluation between them. It might prove pivotal in the case of inter-departmental and international collaboration for environmental/biodiversity law enforcement (e.g., Meeus 2010; Elliott 2017). In Conservation Culturomics, improved intelligence techniques are necessary to accurately predict public interest in conservation; in the biodiversity crime domain, strict ontologies are urgently needed to outline abstract crime concepts and support consequent objective judicial treatment.

Declarations

Acknowledgments

The authors wish to express their thanks to two anonymous reviewers and XXXXXXXXXXXX for helpful comments and assistance during the writing of the manuscript. They dedicate this paper to the loving memory of Professor XXXXXXXX. [*The names XXXXXXXXXXXXXXXXXX will be publicized after the full-blinded review process*].

This research did not receive any specific grant from the public, commercial, or not-for-profit sectors.

There is no Conflict of Interest

All co-authors are mentioned and consent regarding content and submission

No experimentation with Humans and Animals

References

1. Adams, W.M., Aveling, R., Brockington, D., Dickson, B., Elliott, J., Hutton, J., et al. (2004). Biodiversity conservation and the eradication of poverty. Science, 306, 1146–1149.
2. Apel, R. (2013). Sanctions, perceptions, and crime: Implications for criminal deterrence. Journal of Quantitative Criminology, 29(1), 67–101. DOI: 10.1007/s10940-012-9170-1
3. Arponen, A., Cabeza, M., Eklund, J., Kujala, H., & Lehtomaki, J. (2010). Costs of integrating economics and conservation planning. Conservation Biology, 24(5), 1198–1204. DOI: 10.1111/j.1523-1739.2010.01539.x
4. Ayling, J. (2013). Harnessing third parties for transnational environmental crime prevention. Transational Environmental Law, 2(2), 339–362. DOI: 10.1017/S2047102513000174
5. Barrett, C.B., Travis, A.J. & Dasgupta, P. (2011). On biodiversity conservation and poverty traps. PNAS, 108, 13907–13912.
6. Barton B.H. & Moran E (2013). Measuring diversity on the Supreme Court with biodiversity statistics. Journal of Empirical Legal Studies, https://doi.org/10.1111/jels.12000
7. Bates, A.E., Primack, R.B., Moraga, P., & Duarte, C.M. (2020). COVID-19 pandemic and associated lockdown as a "Global Human Confinement Experiment" to investigate biodiversity conservation. Biological Conservation, 248, 108665. DOI: 10.1016/j.biocon.2020.108665
8. Beirne, P., Brisman, A., Sollund, R., & South, N. (2018). Editors' introduction to the special issue: For a green criminology' 20 years and onwards. Theoretical Criminology, 22(3), 295–297. DOI: 10.1177/1362480618787169
9. Biber, E., (2017). Law in the Anthropocene epoch. Georgetown Law Journal, 106(1), 1–68.
10. Blicharska, M., Orlikowska, E.H., Roberge, J-M & Grodzinska-Jurczak, M. (2016). Contribution of social science to large scale biodiversity conservation: a review of research about the Natura 2000 network. Biological Conservation, 199, 110–122
11. Brantingham, J. (2016). Crime diversity. Criminology, 54(4), 553–586.
12. Brisman, A. (2020). Immunity to environmental crime, harm and violence: An ongoing pandemic and a possible narrative vaccine. International Journal of Offender Therapy and Comparative Criminology. Article Number: 0306624X20970885
13. Brisman, A. & South, N. (2019). Green criminology and environmental crimes and harms. Sociology Compass, 13(1), Article Number: e12650.
14. Burivalova, Z., Butler, R.A. & Wilcove, D.S. (2018). Analyzing Google search data to debunk myths about the public's interest in conservation. Frontiers in Ecology and the Environment, 16(9), 509–514. https://doi.org/10.1002/fee.1962.
15. Butchart, S.H.M., Walpole, M., Collen, B., van Strien A., et al. (2010). Global Biodiversity: Indicators of recent declines. Science, 328, 1164–1168.
16. Cafaro, P., (2015). Three ways to think about the sixth mass extinction. Biological Conservation, 192, 387–393.
17. Cardwell, P.J., French, D., & Hall, M. (2011). Tackling environmental crime in the European Union: the case of the missing victim? Environmental Law Management, 23(3), 113–121.
18. Chester, C.C., & Moomaw, W.R. (2008). A taxonomy of collaborative governance: a guide to understanding the diversity of international and domestic conservation accords. International Environmental Agreements, 8, 187–206.
19. Correia, R.A., Jepson, P.R., Malhado, A.C.M., et al. (2016). Familiarity breeds content: assessing bird species popularity with culturomics. PEERJ, 4, e1728
20. Correia, R.A., Jepson, P., Malhado, A.C.M. & Ladle, R.J. (2017). Internet scientific name frequency as an indicator of cultural salience of biodiversity. Ecological Indicators, 78, 549–555.
21. Dauvergne, P. (1999). The environmental implications of Asia's 1997 financial crisis. IDS Bulletin, 30, 31–42.
22. Diaz, S., Demissew, S., Carabias, J., Joly, C., Lonsdale, M., et al. (2015). The IPBES Conceptual Framework—connecting nature and people. Current Opinion in Environmental Sustainability, 14(1), 1–16.

23. Do Vale, I.P. (2015). The cultural defense in the scope of criminal law and criminal procedure: A comparative law vision as paradigm for application at the Brazilian law. Quaestio Juris, 8(2), 758–773. 15
24. Douglas, L.R. & Alie, K. (2014). High-value natural resources: Linking wildlife conservation to international conflict, insecurity, and development concerns. Biological Conservation, 171, 270–277.
25. Duffy, R. (2014). Waging a war to save biodiversity: the rise of militarized conservation. International Affairs, 90(4), 819+
26. Elliott, L. (2017). Cooperation on Transnational Environmental Crime: Institutional Complexity matters. Review of European Community and International Environmental Law, 6(2), 107–117. DOI: 10.1111/reel.12202
27. European Commission/Neemo/Ernst and Young (2016). LIFE: Contributing to the Employment and Economic Growth. Final Report. http://ec.europa.eu/environment/life/publications/
28. Europol (SOCTA 2021). European Union serious and organised crime threat assessment, A corrupting influence: the infiltration and undermining of Europe's economy and society by organised crime, Publications Office of the European Union, Luxembourg. Available at: https://www.europol.europa.eu/activities-services/main-reports/european-union-serious-and-organised-crime-threat-assessment
29. Eysenck, H.I., (1996). Personality and crime: where do we stand. Psycholology Crime Law, 2(3), 143–152. https://doi.org/10.1080/10683169608409773.
30. Farley, J. (2008). The role of prices in conserving critical natural capital. Conservation Biology, 22, 1399–1408.
31. Ficetola, G.F. (2013). Is interest toward the environment really declining? The complexity of analyzing trends using internet search data. Biodiversity and Conservation, 22, 2983–2988.
32. Fischer, A. & Young, J. (2007). Understanding mental constructs of biodiversity: implications for biodiversity management. Biological Conservation, 136, 271–282.
33. Fisher, R., Radford, B.T., Knowlton, N., Brainard, R.E., Michaelis, F.B. & Caley, M.J. (2010). Global mismatch between research effort and conservation needs of tropical coral reefs. Conservation Letters, 4, 64–72.
34. Fulton, M. & Vercammen, J. (2014). Optimal NGO financing of a resource management certification scheme. Environmental and Resource Economics, 58(4), 605–626.
35. Funk, S.M. & Rusowsky, D. (2014). The importance of cultural knowledge and scale for analysing internet search data as a proxy for public interest toward the environment. Biodiversity and Conservation, 23, 3101–3112.
36. Geist, H. & Lambin, E.F. (2001). What drives tropical deforestation? A meta-analysis of proximate and underlying causes of deforestation based on subnational case study evidence. LUCC report series No. 4.
37. Gore, M., Ratsimbazafy, J. & Lute, M. (2013). Rethinking corruption in conservation crime: Insights from Madagascar. Conservation Letters, 6(6), 430–438.
38. Grainger, A. (1993). Controlling tropical deforestation. Earthscan, London.
39. Hoggt, R., & Carrington, K., (1998). Crime, rurality and community. Australian New Zealand Journal of Criminology. Available at: https://doi.org/10.1177/000486589803100204.
40. Hooper, D.U., Chapin, F.S., Ewel, J.J., et al. (2005). Effects of biodiversity on ecosystem functioning: A consensus of current knowledge. Ecological Monographs, 75(1), 3–35.
41. Huebschle, A.M., (2017). The social economy of rhino poaching: of economic freedom fighters, professional hunters and marginalized local people. Current Sociology, 65(3), 427–447.
42. IPBES (2019): Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 pages. https://doi.org/10.5281/zenodo.3831673
43. Jaric, I., Correia, R.A., Roberts, D.L., et al. (2019). On the overlap between scientific and societal taxonomic attentions - Insights for conservation. Science of the Total Environment, 648, 772–778.
44. Irvin, R.A. & Stansbury, J. (2004). Citizen participation in decision-making: Is it worth the effort? Available at: https://smartnet.niua.org/sites/default/files/resources/citizen%20participation%20is%20it%20worth%20the%20effort.pdf

45. Kavish, N. & Boutwell, B. (2018). The unified crime theory and the social correlates of crime and violence: problems and solutions. Journal of Criminal Psychology, 8(4), 287–301. DOI: 10.1108/JCP-06-2018-0028
46. Koju, N.P., Kandel, R.C., Acharya, H., et al. (2021). Covid-19 lockdown sets wildlife free but increases poaching threats in Nepal. Authorea, DOI: 10.22541/au.161701344.41884506/v1
47. Lacey, N., Soskice, D. & Hope, D. (2018). Understanding the determinants of penal policy: Crime, culture, and comparative political economy. Annual Review of Criminology, 1, 195–217. DOI: 10.1146/annurev-criminol-032317-091942
48. Ladle, R., Correia, R.A., Do, Y., Joo, G-J.,, Malhado, A., Proulx, R., Roberge, J.M. & Jepson, P. (2016). Conservation culturomics. Frontiers in Ecology and the Environment, 14(5), 269–275, doi:10.1002/fee.1260.
49. Lambin, E.F., Geist, H. & Rindfuss, R.R. (2006). Introduction: local processes with global impacts. In (E. Lambin and H. Geist, eds) Land-Use and Land-Cover Change: Local processes, global impacts. Global Change IGBP Series, Springer-Verlag, Berlin. Germany. Chapter 1, 1–8.
50. Le Gallic, B., (2008). The use of trade measures against illicit fishing: economic and legal considerations. Ecological Economics, 64(4), 858–866.
51. Leberatto, A.C. (2017). A typology of market sellers of protected wildlife across Peru. Deviant Behavior, 38(12), 1352–1370. DOI: 10.1080/01639625.2016.1254963
52. Lekakis, J.N. & Kousis, M. (2013). Economic crisis, Troika and the Environment in Greece. South European Society and Politics,18(3), 305–331.
53. Lievano-Latorre, L.F., Brum, F.T., & Loyola, R. (2021). How effective have been guerrilla occupation and protected areas in avoiding deforestation in Colombia? Biological Conservation, 253, 108916. DOI10.1016/j.biocon.2020.108916
54. Lynch, M.J., Stretesky, P.B., & Long, M.A., (2017). Blaming the poor for biodiversity loss: a political economic critique of the study of poaching and wildlife trafficking. Journal of Poverty and Social Justice, 25 (3), 263–275.
55. Maas, B,, Toomey, A. & Loyola, R. (2019). Exploring and expanding the spaces between research and implementation in conservation science. Biological Conservation, 240, 108290
56. Mascia, M.B. & Pailler, S. (2011). Protected area downgrading, downsizing, and degazettement (PADDD) and its conservation implications. Conservation Letters, 4(1), 9–20 DOI: 10.1111/j.1755-263X.2010.00147.x
57. McCallum, M.L. & Bury, G.W. (2013). Google search patterns suggest declining interest in the environment. Biodiversity and Conservation, 22, 1355–1367.
58. Meeus R. (2010). Fill in the gaps: EU sanctioning requirements to improve Member State enforcement of EU Environmental Law. Journal for European Environmental and Planning Law, 7(2), 135–162.
59. Meir, E., Andelman, S. & Possingham H.P. (2004). Does conservation planning matter in a dynamic and uncertain world? Ecology Letters, 7(8) DOI:10.1111/j.1461-0248.2004.00624.x
60. Michel, J-B., Shen, Y.K., Aiden, A.P., Veres, A., Gray, M.K., et al. (2011). Quantitative analysis of culture using millions of digitized books. Science, 331, 176–182.
61. Moreto, W.D., (2017). Avoiding the tragedy of (un)common knowledge: reflections on conducting qualitative criminological research in conservation science. Qualitative Research, 17(4), 440–456.
62. Nghiem, L.T.P., Papworth, S.K., Lim, F.K.S. & Carrasco, L.R. (2016). Analysis of the capacity of Google Trends to measure interest in conservation topics and the role of online news. Plos ONE, DOI:10.1371/journal.pone.0152802, 12 p.
63. Novacek, M.J. (2008). Engaging the public in biodiversity. PNAS, 105(1), 11571–11578.
64. Pascual, U., Balvanera, P., Diaz, S., Pataki, G., Roth, E., et al. (2017). Valuing nature's contributions to people: the IPBES approach. Current Opinion in Environmental Sustainability, 26–27, 7–16. DOI: 10.1016/j.cosust.2016.12.006
65. Perrings, C., Naeem, S., Ahrestani, F., Bunker, D.E., et al. (2010) Ecosystem Services for 2020. Science, 330, 323–324.
66. Petersen, A.M., Tenebaum, J.N., Havlin, S., Stanley, E. & Perc, M. (2012). Languages cool as they expand: Allometric scaling and decreasing need for new words. Scientific Reports, 2, 943. DOI: 10.1038/srep00943

67. Pogarsky, G., Roche, S.P. & Pickett, J.T. (2018). Offender decision-making in criminology: Contributions from behavioral economics. Annual Review of Criminology, 1, 379–400. DOI: 10.1146/annurev-criminol-032317-092036
68. Proulx, R., Massicotte, M. & Pepino, M. (2013). Googling trends in conservation biology. Conservation Biology, 28, 44–51.
69. Rizzolo, J.B., Gore, M., Ratsimbazafy, J. & Rajaonson, A. (2017). Cultural influences on attitudes about the causes and consequences of wildlife poaching. Crime Law and Social Change, 67(4), SI, 4150437.
70. Robinson, S., & Milner-Gulland, EJ. (2003). Political change and factors limiting numbers of wild and domestic ungulates in Kazakhstan. Human Ecology, 31, 87–110.
71. Rodriguez, J.P. (2000). Impact of the Venezuelan economic crisis on wild populations of animals and plants. Biological Conservation, 96, 151–159.
72. Rodriguez Goyes, D., & Sollund, R. (2018). Animal abuse, biotechnology and species justice. Theoretical Criminology, 22(3), 363–383
73. Roll, U., Mittermeier, J.C., Diaz, G.I., Novosolov, M., et al. (2016). Using Wikipedia page views to explore the cultural importance of global reptiles. Biological Conservation, 204, Part A, 42–50.
74. Rose, G.L. (2011). Gaps in the implementation of environmental Law at the national, regional and global level. First Preparatory Meeting of the World Congress on Justice, Governance and Law for Environmental Sustainability. Kuala Lumpur, Malaysia: UNEP, 30 p. http://ro.uow.edu.au/cgi/viewcontent.cgi?article=2684andcontext=lhapapers
75. Rounsevell, M.D.A., Dawson, T.P. & Harrison, P.A. (2010). A conceptual framework to assess the effects of environmental change on ecosystem services. Biodiversity and Conservation, 19(10), 2823–2842.
76. Runhovde, S.R. (2017). Comparing discourse to officer perceptions: The problems of war and militarization in wildlife crime enforcement. Critical Criminology, 25(2), SI, 275–291.
77. Secretariat of the Convention on Biological Diversity (2005). Handbook of the Convention on Biological Diversity Including its Cartagena Protocol on Biosafety, 3rd edition, (Montreal, Canada). Available at: https://www.cbd.int/doc/handbook/cbd-hb-all-en.pdf
78. Solomon, J.N., Gavin, M.C. & Gore, M.L. (2015). Detecting and understanding non-compliance with conservation rules. Biological Conservation, 189, SI, 1–4.
79. Stroh, M., Eichinger. M., Giza, A., Hirschmann, N., Bögelein. N., Pitsela, A., Neubacher, F. (2016). Are female offenders underreported compared to male offenders? A German-Greek comparison of crime reporting, rating of offence seriousness and personal experiences of victimisation. European Journal on Criminal Policy and Research, 22(4), 635–653.
80. Sundstrom, A., (2016). Understanding illegality and corruption in forest governance. Journal of Environmental Management, 181, 779–790.
81. Sutherland, W.J., Butchart, S.H.M., Connor, B., Culshaw, C., et al. (2018). A 2018 horizon scan of emerging issues for global conservation and biological diversity. TREE, doi.org/10.1016/j.tree.2017.11.006
82. Tittensor, D.P., Walpole, M., Hill, S.L.L., Boyce, D.G., Britten, G.L., et al. (2014). A mid-term analysis of progress toward international biodiversity targets. Science, 346, 6206, 241–244.
83. Toivonen, T., Heikinheimo, V., Fink, C., Hausmann, A., Hiippala, T., et al. (2019). Social media data for conservation science: A methodological overview. Biological Conservation, 233, 298–315.
84. Tosun, J., (2012). Environmental monitoring and enforcement in Europe: a review of empirical research. Environmental Policy Governance, 22, 437–446. https://doi.org/10.1002/eet.1582.
85. XXXX (2017a). Reference to be publicized after CLSC review
86. XXXX (2017b). Reference to be publicized after CLSC review
87. XXXX (2019). Reference to be publicized after CLSC review
88. XXXX (2021). Reference to be publicized after CLSC review
89. XXXX and XXXX (2020). Reference to be publicized after CLSC review

90. XXXX and XXXX (2020). Reference to be publicized after CLSC review
91. Wilde, G.R. & Pope, K.L. (2013). Worldwide trends in fishing interest indicated by internet search volume. Fisheries Management and Ecology, 20, 211–222.
92. Zhu, L.J. (2014). Chinese practice in public international law: 2013. Chinese Journal of International Law, 13(2), 395–454. DOI: 10.1093/chinesejil/jmu019

Figures

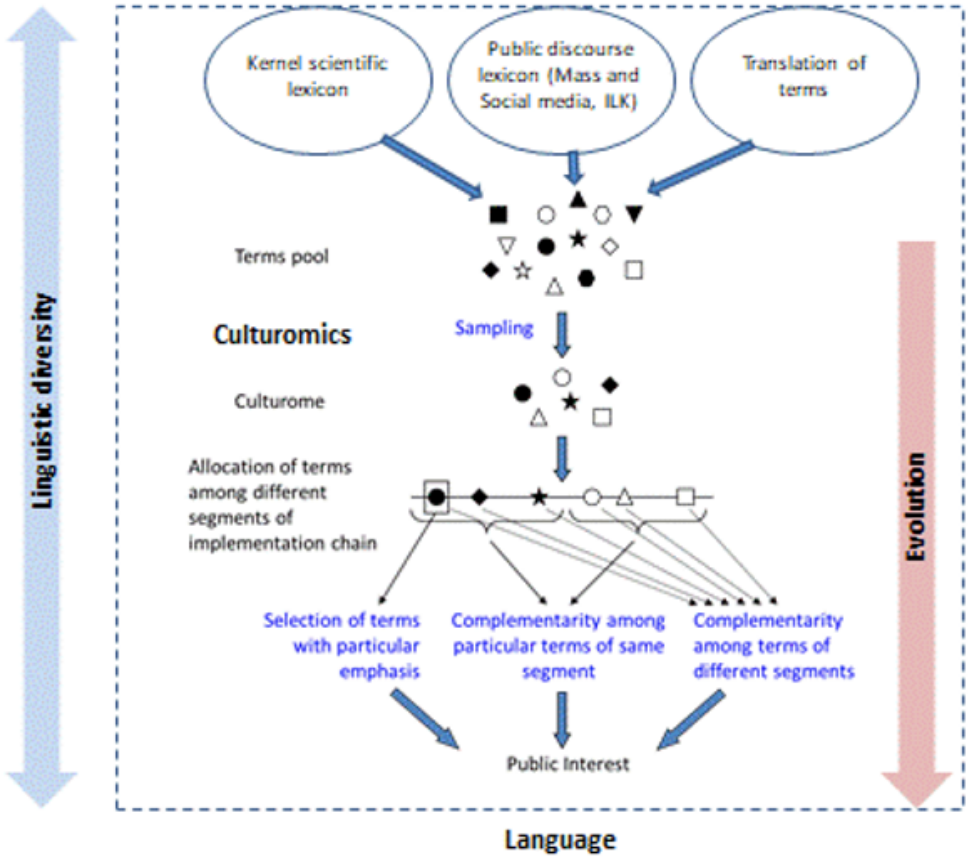

Figure 1

Specialized Internet services provide sets of associated terms (e.g., Google Adwords Tool, Wordstream Free Keywords Tool, Keywords Everywhere). Such associations present trend lines of crowd search volumes and altogether form evolving culturomes with a series of properties.

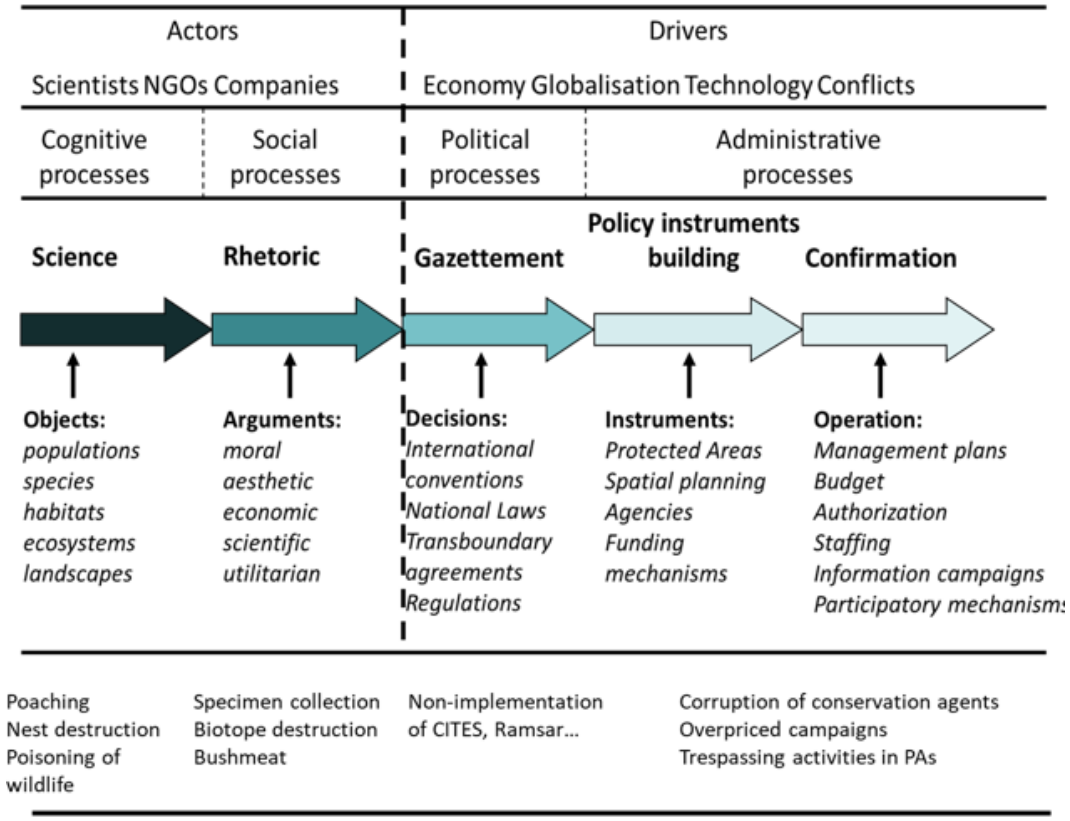

Figure 2

The simplified linear conceptual model depicts a 5-stage ideal implementation process for conservation policy presented in Figure.

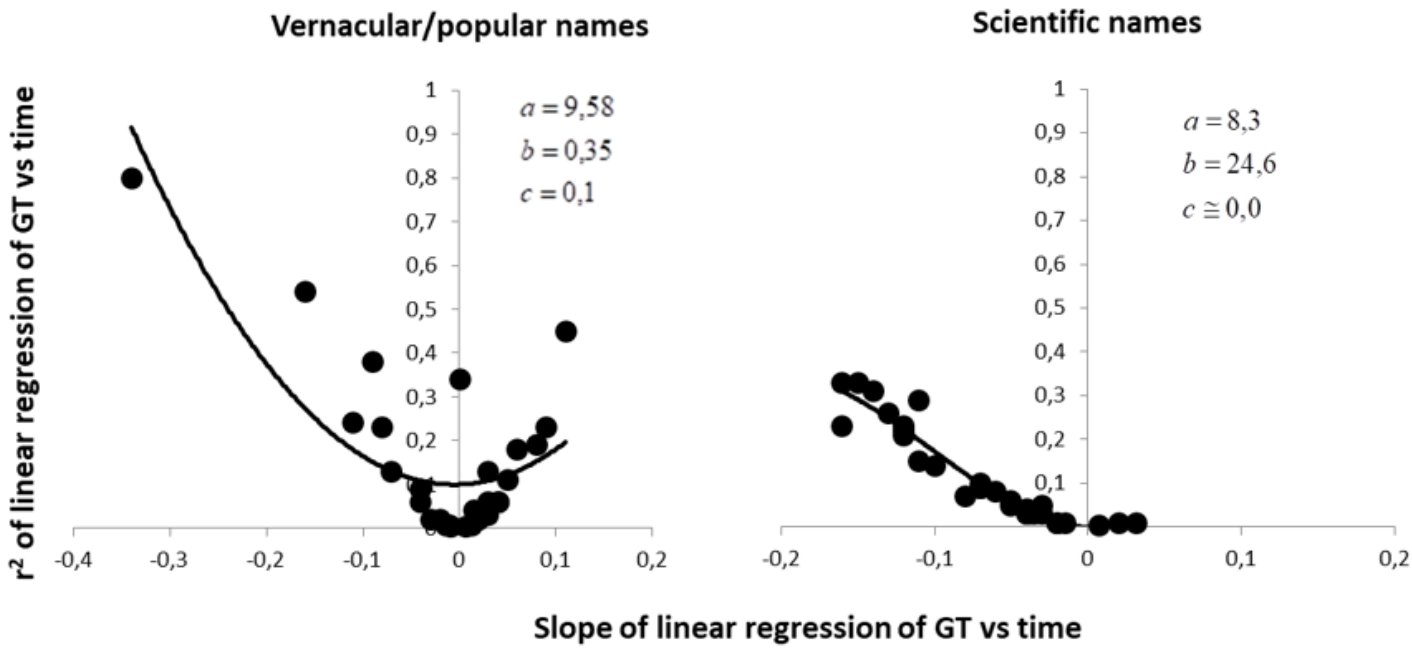

Figure 3

Figure presents the ordination in a 2D slope (x-axis) – r2 (y-axis) plane of the two collections of species: (a) popular species after their vernacular name; (b) species after their scientific names.

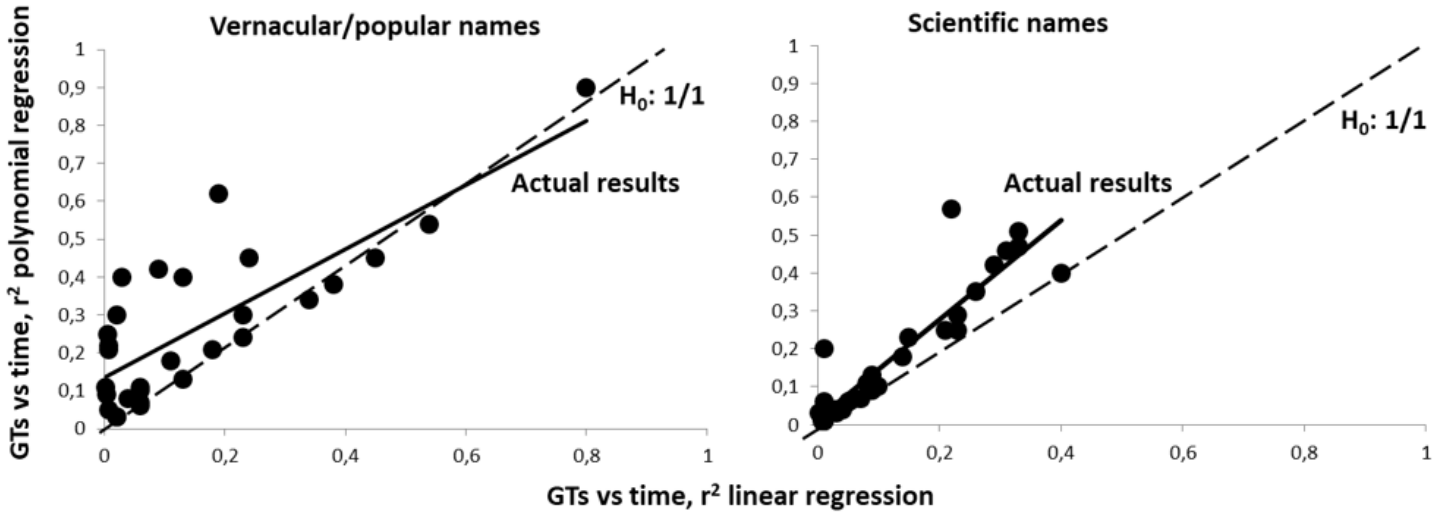

Figure 4

Figure presents linear vs. cyclical trends of public interest in the two collections of species nomenclature. In both cases, the predictor of individual term results was time, and the response variable was search-volume/term as expressed by corresponding GTs.

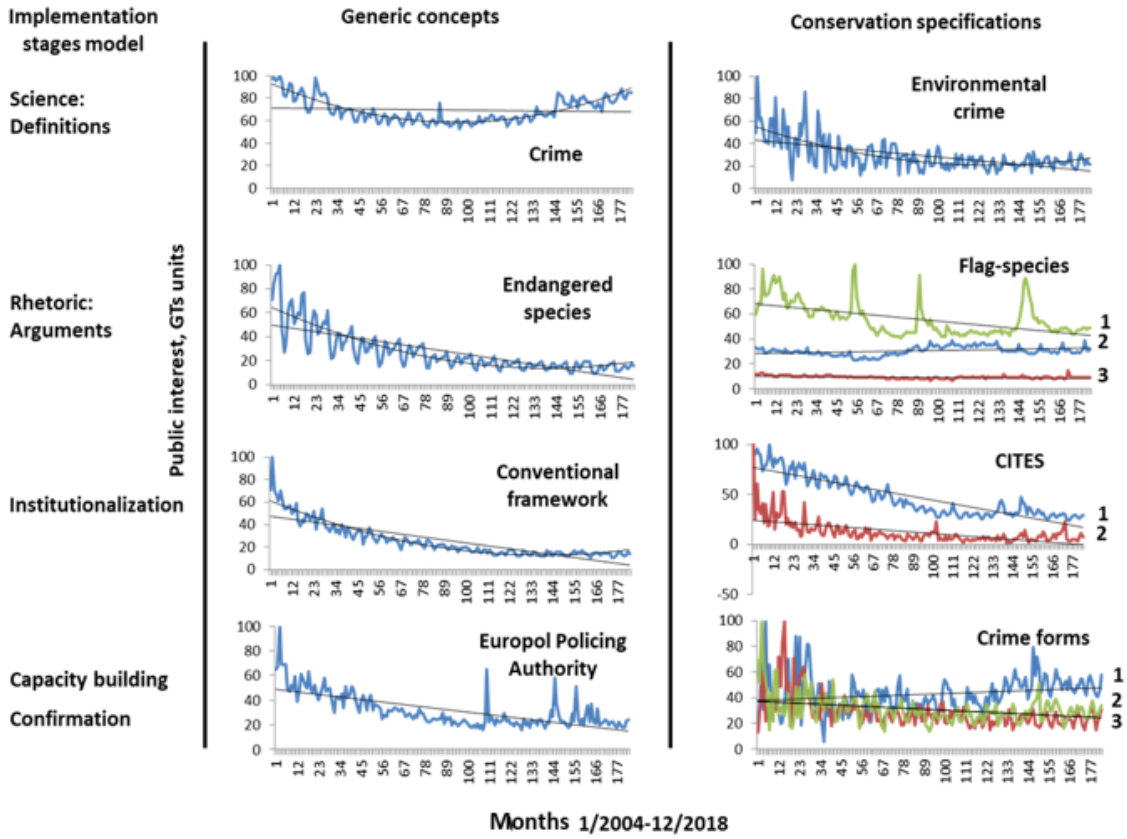

Figure 5

Figure presents normalized GTs crowd-search data to identify –mostly- long-term linear evolution of the global public interest in the selected topics of the conservation implementation chain during 1/2004-8/2020.

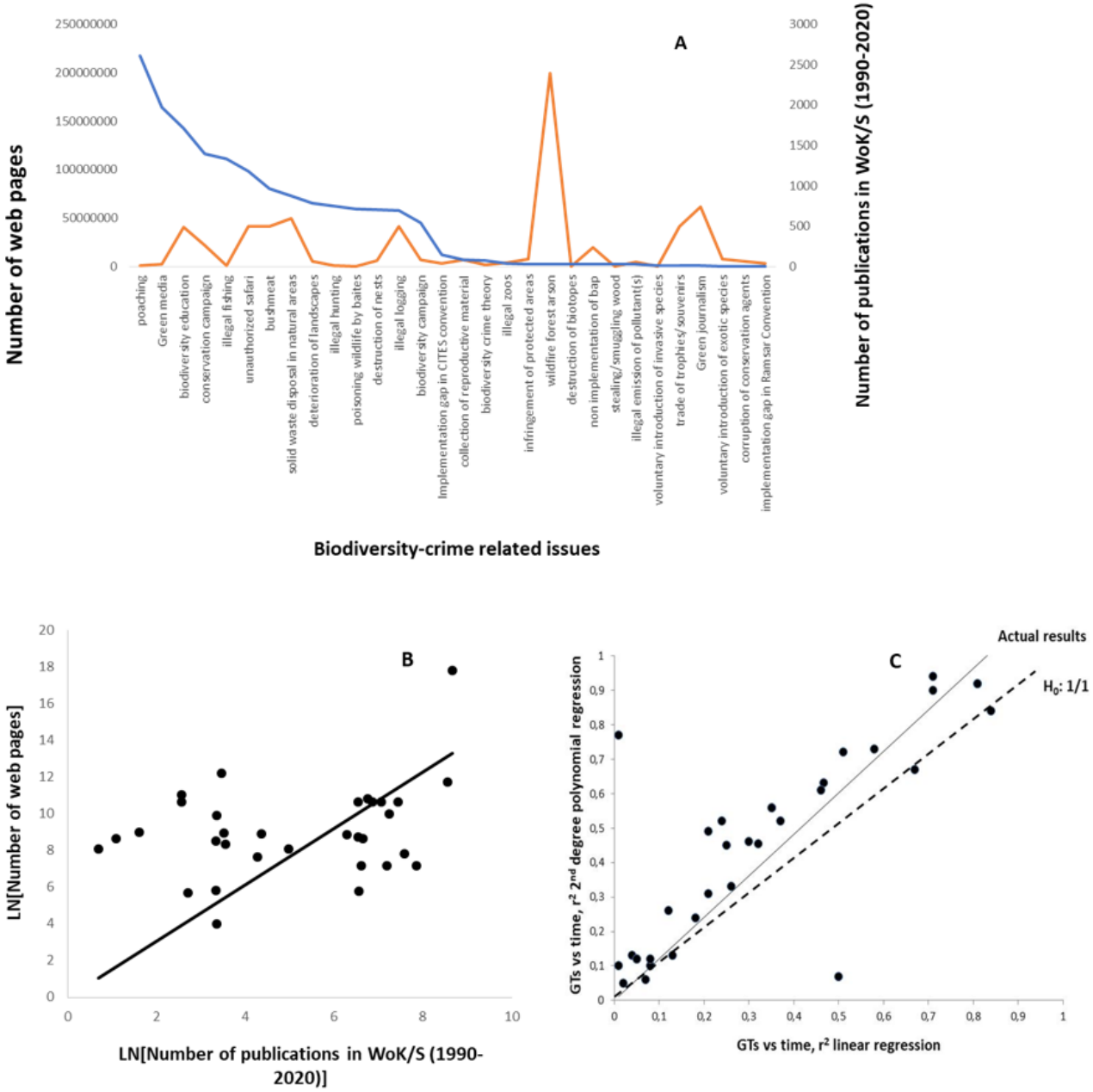

Figure 6

Figure [A, B, C] presents a synthesis of long term evolution of an ensemble of ca 30 biodiversity crime-related concepts available in two different media environments: (1) scientific publications cataloged in WoK/S, 'the scholar pool of knowledge'; and, (2) number of web pages, 'the public pool of knowledge', dedicated to the same issues.

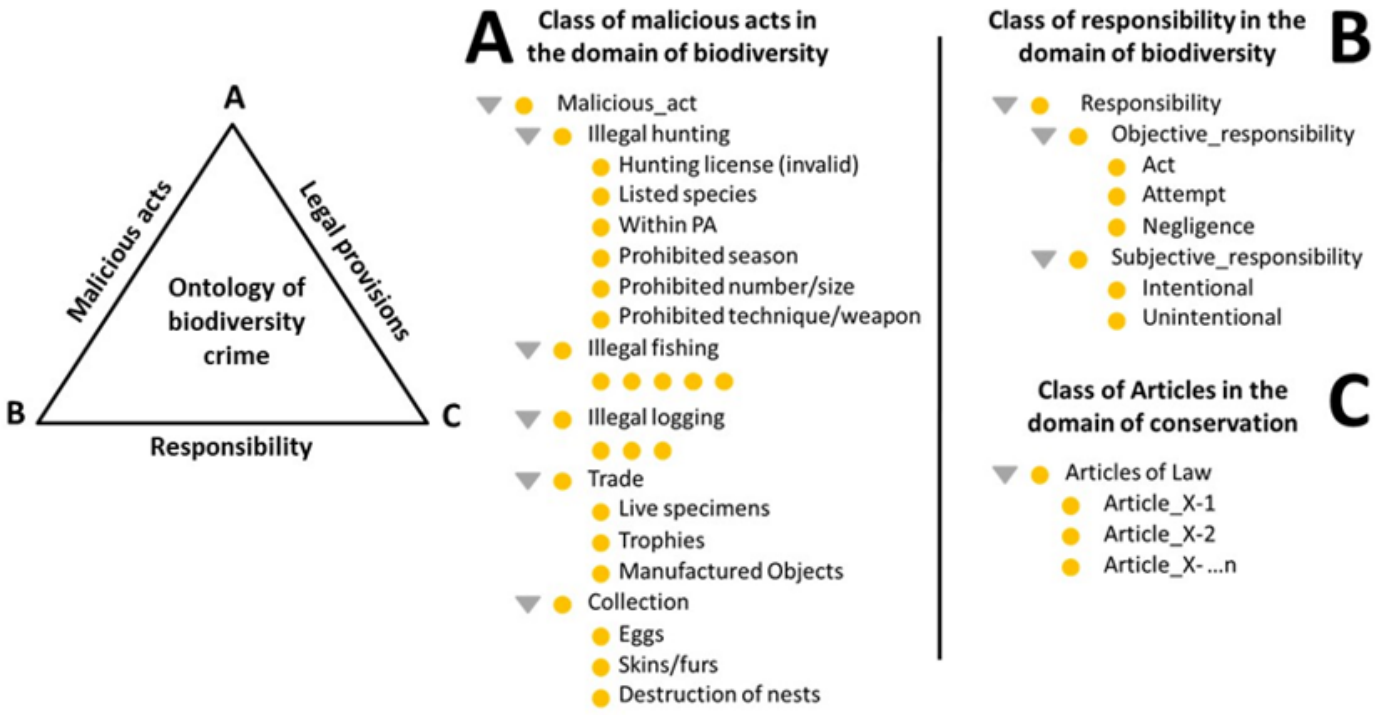

Figure 7

Figure presents such an ontology and a typology of biodiversity crime.