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North Africa as a source for European eel following the 2010 EU CITES eel trade ban

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ABSTRACT

In 2007 CITES included the Critically Endangered European eel on its Appendix II, thereby regulation international trade. In 2010 the EU member states adopted a 'zero-quota' policy thereby banning all commercial international trade. Given the continued high demand for eel in East Asia shifts have occurred to source European eel from non-EU eel range countries. Using official export figures from two independent databases, I here quantify to what extend Morocco, Tunisia and Algeria are fulfilling this demand. The ban had little effect on the annual export volumes in live eel from Morocco (mean of 41.3 metric ton / year), Algeria (15.5 t) or Tunisia (56.2 t) or chilled/frozen eel from Algeria (11.7 t) and Tunisia (20.0 t) but this trade from Morocco increased significantly (from 27.4 to 237.2 t). Prior to the ban the trade in eel from North Africa was almost exclusively to European countries (live 93–98%) and very little to East Asia, whereas after the ban East Asia became the main importer (live 91–93%). The monetary value of the trade totalled US$126 million and did not increase over time, but the importance of the live eel trade increase from 76% prior to the ban to 93% after. It is unclear on what basis Morocco and Tunisia were able to decide what level of trade was not detrimental to the survival of European eel in the wild, and I argue for better monitoring to ensure that international trade is not an impediment to the conservation of European eel.

1. Introduction

In March 2009 the European eel *Anguilla anguilla* was listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), after an agreement was reached at the 14th Conference of Parties in June 2007 [1]. Appendix II lists species that are not necessarily threatened with extinction at present, although the European eel clearly is, but that may become so unless trade is closely controlled; international trade in Appendix II species may be authorized by the granting of an export permit or re-export certificate if the relevant authorities are satisfied that trade will not be detrimental to the survival of the species in the wild.

European eel exhibits facultative catadromy, living mostly in fresh, brackish and coastal waters, but migrating to pelagic oceanic waters to breed and migrating 1000 s of km to their breeding grounds [2–4]. Their non-breeding range includes most of Europe and small parts of North Africa (Morocco, Algeria, Tunisia, Egypt) and the Middle East (Israel, Palestine, Lebanon, Syria, Turkey) [5]. Since 2008, the European eel has been listed as Critically Endangered on the IUCN Red List of Threatened Species, having seen a 90–95% decline in recruitment over the last few decades (prior to 2008 its conservation status had not been assessed) [5]. Controlling and regulating international trade is one way to lessen threats to eels. European eel is a panmictic species, breeding in a single location in the Sargasso Sea, and once at the spawning area, eels from one part of their European range can potentially breed with eels from each and every part of their range 6, 7]. As such, the proportion of the population from a specific river/country/region that is able to return to their breeding grounds is not equivalent to the subsequent recruitment as this relies on the spawning stock as a whole, irrespective of escapement location [5]. Any change in fisheries of eel (increase, decrease, targeting different age classes, etc.) in one part of the species range (e.g. Dutch waters or the coast of Portugal) can, perhaps decades later, have an effect on recruitment in another part (e.g. Sweden, Italy) even if conditions there remain the same. The eel trade in and out of Europe, and what has changed over time, has been reviewed [5–8].

As part of the CITES listing, exporting countries were required to make so-called Non-detriment Finding (NDF) indicating that the proposed volume of European eel that are to be exported is within safe limits [9]. The European Union (EU) countries, in addition to being significant consumers of eel, were the major exporters of the species. After three years of deliberation the EU CITES Scientific Review Group

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comprising all EU Scientific Authorities, responsible for establishing NDFs, were unable to determine that trade would not be detrimental to the conservation of the species. Consequently, in December 2010, the EU took the stricter measure of adopting a 'zero-export quota', and banning all imports and exports of European eel to and from the EU [10].

Prior to the EU ban, a large proportion of European eel fished in European waters was exported to East Asia, principally Japan and China where a substantial proportion was used for aquaculture [11]. The different live stages of eel are traded differently, with for instance live glass eels and juveniles that are used for aquaculture in East Asia being the most priced commodities, and frozen or chilled adult eels that are traded for meat in Europe fetching lower prices. Following the ban, a shift has occurred with other species of eel being imported from American and Southeast Asian countries [12–14]. With all EU countries adopting a ban in international trade, other non-EU European eel range countries have stepped in to meet the East Asian demand for European eel, including Morocco and Tunisia [12,15], and potentially other North African countries. As with all eel trade, the export of eel out of North Africa either concern wild-caught eel directly or wild-caught eel that has been kept in aquaculture for a period of time ('eel farming'); captive breeding of eel does not takes place.

Here an overview of the international trade in European eel from North African range countries, primarily Morocco, Algeria and Tunisia, is given focusing on the years subsequent to the CITES Appendix II listing and establishing to what extent these countries have filled the void left by the EU countries in the global eel market following the 2010 trade ban. Morocco, Algeria and Tunisia have strong historical, economic, cultural/linguistic and political ties to Europe, especially France and Spain. Currently all three countries participate in the Euro-Mediterranean free trade area agreement with the EU that aims at removing barriers to trade and investment between the EU and southern Mediterranean countries. Of relevance for eel management, Morocco, Algeria and Tunisia are signatories to the Bonn Convention on the Conservation of Migratory Species of Wild Animals (CMS; Morocco 1993, Algeria 2005, Tunisia 1987) and CITES (Morocco 1976, Algeria 1984, Tunisia 1975). As early as 1996 continent-wide coordinated action was proposed to better manage and protect European eel, under the Bern Convention on the Conservation of European Wildlife and Natural Habitats, but no action was taken [16]. Morocco (2001) and Tunisia (1996) are Party to the Bern Convention and Algeria has a non-signatory observer status.

2. Methods

2.1. Data acquisition

All data used in this study were downloaded in July 2016. Firstly data on commercial eel trade were downloaded from United Nations Commercial Trade database (UN Comtrade, comtrade.un.org; hereafter UN Comtrade database) for the period 2007 to May 2016, with Mauritania, Morocco, Algeria, Tunisia, Libya and Egypt as the exporter or as the source country. Search terms included live eel (Harmonized System (HS) commodity code 030192), fresh or chilled whole eel (HS030266) and frozen whole eel (HS 030376), and both data on volumes (reported in kg, here converted to metric ton, t) and values (in US $), were extracted, and transferred to a database. When figures differed between data reported with the North African countries as a 'reporter' or as a 'partner' (with importing countries as 'reporters'), the largest figure was taken. The rationale behind this was that under-reporting, i.e. declaring to international bodies that less eel is imported or exported than what actually was imported or exported, is more likely to occur rather than over-reporting. Apparent missing data were left blank (see Results). Secondly data was obtained for the period 2009–2015 from the CITES trade database (www.citestrade.org), using the North African countries as exporters, extracting data on volumes (in kg) only. Fingerlings (i.e. young eels) were included with the live trade; almost all trade was reported in kg, occasionally no measurement unit was provided and instead of assuming these then represented individual eels or fingerlings it was included it as kg (e.g. in 2014 South Korea reported the import of 163,822 European eel from Morocco without providing a unit of measurement; it is more likely that this represented kg of eel rather than a count of individuals).

2.2. Analysis

There were clear discrepancies and deficiencies both within and between the two datasets. In some cases it was evident that this was due to not reporting trade by one or more parties, for instance in the UN Comtrade database Tunisia did not report any export of live eel in 2013, whereas importing countries (South Korea, Russia, Egypt, United States of America) reported the import of a total of 66.8 t of live eel from Tunisia. In 2012 in the UN Comtrade database Morocco did not report any export (or import) of frozen/chilled eel whereas in 2011 and 2013 it reported the export of 48.0 t and 144.0 t, respectively. When importing and exporting parties report eel trade in the same year, the highest volumes were selected and corresponding values; in cases where one party did not report but the other did, data from the party that did report were used; when neither importing or exporting parties report trade for a given year, but trade is reported for the previous year and the preceding year, the apparent missing data were substituted with the mean of the two years (these inference were made for Morocco, adding 96.0 t of frozen/chilled eel, or 6.8%, to the country's total and Algeria, adding 10.6 t of frozen/chilled eel, or 6.6%, to the country's total). When two or more years are missing from both importers and exporters there were not enough data available to infer levels of trade. Given that the EU zero quota came into force in only at the end of 2010 in December 2010 is included in the pre-ban period (noting that CITES export permits have a validity of up to six months so legal export could have continued until May 2011).

Data were checked whether or not they deviated from a normal distribution and if needed were log-transformed prior to analysis. Values are reported as means ± one standard error of the mean. Monetary values were reported in US$ and these were adjusted for inflation to 2016 values so that prices became comparable between years (e.g. 1 US$ in 2016 was worth 1.17 US$ 2007). Statistics were computed using SPSS17 and significance was accepted when $P < 0.05$ in a two-tailed test.

3. Results

3.1. Volumes of trade

Trade in eel was predominantly from Morocco, Algeria and Tunisia (see below). Trade from other North African countries was insignificant compared to Morocco, Algeria and Tunisia and all trade was reported by importing countries only. No trade was reported for Libya over the ten-year study period, whereas Spain reported the import of 0.25 t of frozen eel from Mauritania in 2010 (UN Comtrade database) and South Korea reported the import of 50 kg of live eel from Mauritania in 2013 (CITES trade database). Trade from Egypt averaged 0.4 t / year for chilled/frozen eel, mostly reported by European and Middle Eastern countries, and the trade in live eel averaged 0.3 t / year, mainly to Tunisia and Hong Kong.

The average amount of eel exported out of Morocco (2006–2015) according to the UN Comtrade database is 41.3 ± 18.2 t / year for live eel and 120.6 ± 69.0 t / year for chilled and frozen eel; there was no significant difference between the export before the EU export ban 2006–2010 inclusive) or after the ban 2011–2015) for live eel (*t*-test on log-transformed data, $t = 1.19$, $P = 0.269$) but volumes were significantly higher for the trade in chilled and frozen eel (prior 27.4 ± 8.5 t / year, after 237.2 ± 142.5, $t = 3.03$, $P = 0.019$). Trade

volumes reported in the CITES trade database covered the period 2009–2015 and the average amount of eel exported over this period was 35.2 ± 28.9 t / year for live trade, with no difference prior or after the EU trade ban (t = 0.94, P = 0.400). Trade in chilled/frozen eel averaged 42.0 ± 30.8 t / year or excluding two years during which no trade was reported, 84.0 ± 49.0 t / year. While there were differences between the two datasets for years where data from both were available, there was no significant difference between the two (paired *t*-test, t = 0.21, P = 0.838).

The average amount of eel exported out of Algeria according to the UN Comtrade database for the period 2006–2010 is 15.5 ± 3.5 t / year for live eel and 11.7 ± 3.5 t / year for chilled and frozen eel. No data were reported by either Algeria or importing parties after 2010. Only two years with records of eel trade out of Algeria are recorded in the CITES trade database, i.e. 12 t in 2009 (with 22 t reported by the importing countries, Spain, Italy and Tunisia) and 30 t in 2015 (reported by Tunisia).

The average amount of eel exported out of Tunisia (2006–2015) according to the UN Comtrade database is 56.2 ± 10.5 t / year for live eel and 20.0 ± 7.8 t / year for chilled and frozen eel; there was no significant difference between the export before the EU export ban 2006–2010 inclusive) or after the ban 2011–2015) (t = 1.45, P = 0.186 and t = 0.97, P = 0.363 for fresh and chilled/frozen, respectively). The CITES trade database covered the period 2010–2015 and the average amount of eel exported over this period was 44.3 ± 14.3 t / year for live trade and 73.9 ± 35.1 t / year for chilled/frozen eel. For years where data was available from both datasets (CITES and UN trade databases) there was no significant difference between reported volumes (paired *t*-test, t = 0.84, P = 0.428) (Fig. 1).

3.2. Destinations

Based on the UN trade database, prior to the EU trade ban almost all eel from Morocco, Algeria and Tunisia was exported to the EU, and for the period 2006–2010 the main importers of live eel were Italy (313.6 t, or 56.8%) and Spain (219.3 t or 39.7%). Only a small amount (4.1 t, or 0.7%) was exported directly to China and Hong Kong (in 2010). After the EU trade ban, East Asia became the main destination, importing 318.9 t or 92.7% of the live trade, and of the EU countries only Italy, in 2011, imported 10.5 t, or 3.1% of the exported eel (possibly on the basis of permits granted at the end of 2010). The trade in chilled/frozen eel likewise shifted from Europe being the main importer prior to the EU trade ban (145.4 t, or 72.6%), whereas after the ban a shift occurred to Nigeria (108.7 t, or 63.1%) and East Asia (44.0 t, or 25.5%). Data from the CITES trade database show a similar picture. Prior to the EU trade ban most live eel trade from North Africa was exported to the EU (94.9 t, or 92.7%) and only a small amount to East Asia (7.5 t, or 7.3%) whereas thereafter most went to East Asia (368.5 t, or 91.1%) and none to Europe. The non-live trade from North Africa as reported to the CITES Secretariat has been largely to East Asia and not to the EU. In 2010, prior to the ban, all trade was reported to China and Hong Kong (72.6 t) and in the period 2011–2015, 75.3% of the trade (or 436.9 t) was directed to East Asia, with the remainder mainly being exported to Russia and the Ukraine.

3.3. Monetary value

No data on monetary value are available in the CITES trade database so this section is based on the UN Comtrade database only. There was a strong correlation between the annual value of the eel trade as reported by the exporting countries and the importing countries (Pearson's r = 0.729, n = 35, P = 0.0001) with prices reported by

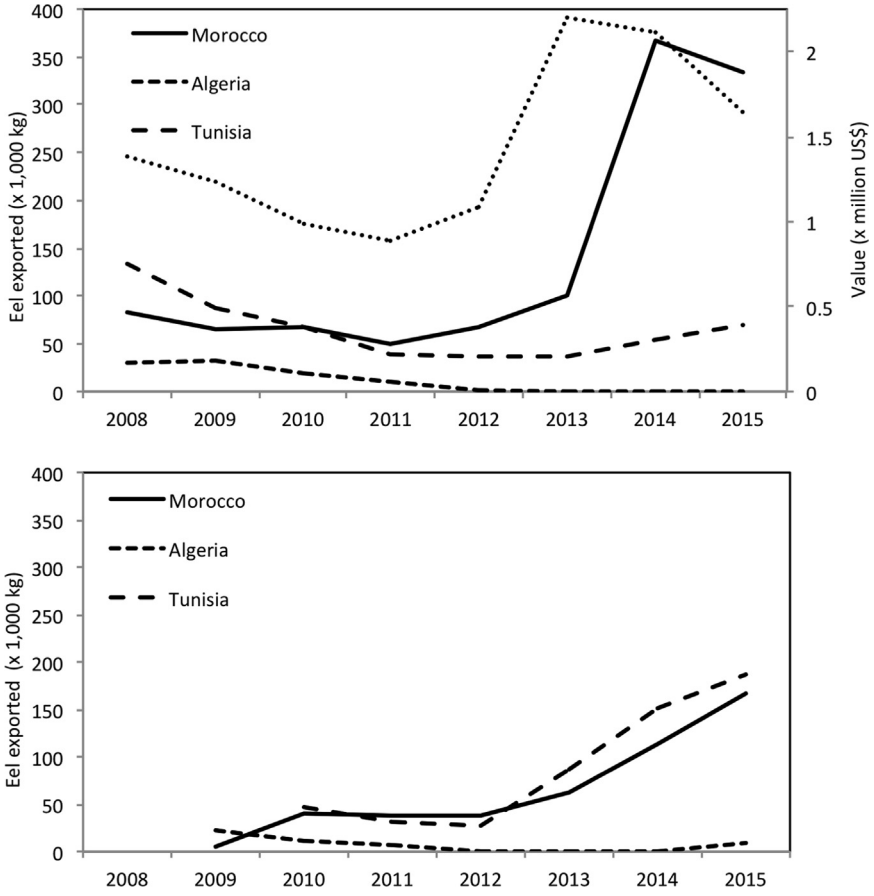

Fig. 1. European eel trade (live, frozen, chilled) from three Morocco, Algeria and Tunisia in the period 2006–2015 showing 3-year running means, based on data from the UN Commercial trade database (top) and on the CITES trade database (bottom). The monetary value of trade (dotted line) is only available for UN trade database data and is based on values reported by importing parties for all three countries combined.

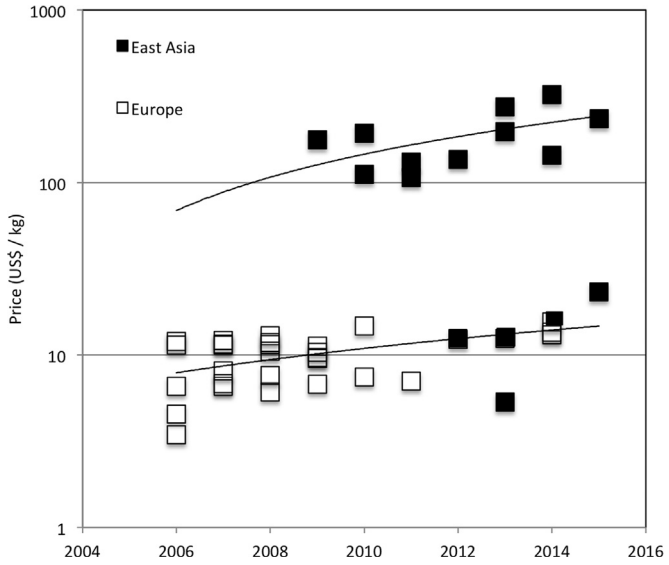

Fig. 2. Inflation corrected prices of live eel (in US$ per kg) imported from North Africa as reported by importing countries showing two distinct types of eel, i.e. one that averages at around US$12 / kg and that prior to the 2010 EU trade ban was largely exported to Europe and after 2010 to East Asia (one of the three 2014 data points is to Russia), and one that averages around US$ 185 / kg and that is exclusively exported to East Asia. Excluded is the import of 270 kg of live eel from Tunisia to South Korea in 2011 valued at US$ 755 / kg. Note the logarithmic scale on the y-axis.

exporters on average being 36% less than that of importers. The total inflation corrected value of all eel trade from North Africa as reported by the importing countries over the ten year period between 2006 and 2015 averaged US$1.257 ± 0.35 million / year, with 85.5% of this comprising the trade in live eels. The value of the trade did not change over time ($r = -0.364$, $n = 10$, $P = 0.133$), but the economic importance of the live eel trade compared to the trade in chilled/frozen increased after 2010, from 75.5% to 93.0%.

With respect to the monetary value of the trade in live eels, two types can be recognised (Fig. 2). The first one comprises the trade of live eel valued at around US$12 / kg and that significantly increases over time from an average of US$8.61 / kg in 2006–2007 to US$16.38 / kg in 2014–2015 ($r = 0.4692$, $n = 32$, $P = 0.007$). Prior to the 2010 EU trade ban this type was largely exported to Europe, and after 2010 to East Asia. The second one comprises trade exclusively to East Asia that commenced in 2009 with eel valued at around US$185 / kg, which does not significantly increase over time ($r = 0.212$, $n = 12$, $P = 0.508$; exclusion of one anomalous value of US$755 in 2011 does not significantly change the outcome: $r = 0.529$, $n = 11$, $P = 0.094$).

4. Discussion

Hitherto limited data have been available on the eel trade from North African countries to East Asia, and most of this focussed on Morocco (e.g. [4,17]). Crook and Nakamura [12] noted that on the basis of Asian customs data Hong Kong first started importing live glass eel from Morocco in 2009, mainland China in 2010 and South Korea in 2011, totalling 7.3 t. From the data reported to the UN and CITES trade databases by both exporters and importers it becomes clear that the role of North African countries in the export of European eel has changed since the EU adopted a zero quota in December 2010. Mauritania, Libya and Egypt, and to a lesser extent Algeria, did not play a major role in this trade prior to the trade ban and this did not change subsequently. Morocco and Tunisia in contrast were already significant exporters of European eel with most of this trade directed to Europe (and may have been re-exported to East Asia). When the EU imposed an import and export ban, Morocco and Tunisia were in an excellent position to meet the demand from countries like China, South Korea and Japan. Apart from the trade in live eel from Morocco it appears that the quantity of eel exported from North Africa did not increase but instead it was directed to other markets and in the last five years annually some 110 t of live eel and 200 t of chilled/frozen eel is exported. The ten-fold increase in trade in chilled/frozen eel from Morocco following the 2010 ban was significant and suggests that exporters in Morocco have both diversified and intensified this trade. Lack of data from some countries for some years, late reporting, conflicting reports about volumes of trade from importing and exporting countries, and decisions to include or exclude certain years in the analysis, is unlikely to lead to an increase or decrease of more than 10% to these numbers. In terms of live the live eel trade, there appears to have been a shift to exporting the more valuable younger eels (glass and fingerlings).

For the period when both UN Comtrade data and CITES trade data were available, the overall pattern in trade in eel from North Africa is similar (Fig. 1), but the volume of trade differs somewhat. Reporting to the UN Comtrade is normally done by the various departments or ministries of fisheries, whereas reporting to the CITES Secretariat is done by each country's CITES Management Authority. It is clear that there are serious backlogs in reporting to the CITES Secretariat by various North African countries (Mauritania, Algeria, Egypt) and this can in part explain discrepancies between databases. Errors in reporting, deliberate or accidental, differences in terminologies used, and variations in how data are collected and collated may lead to additional discrepancies.

In the future, with demands in East Asia remaining high, levels of trade may increase above current levels. When corrected for inflation the monetary value of the trade remained relatively constant at US$ 1.25 million / year. The type of eel traded may have changed somewhat as higher value eel was traded to East Asia after the 2010 trade ban; this most likely related to size as smaller individuals are more expensive by mass. Based on Eurostat's Comext database Motova [18] summarizes the trade of eel in Europe after the trade ban and gives (inflation corrected) prices of the equivalent of US$ 12.30 / kg for eel traded within the EU (with small eel < 12 cm in length fetching double the amount per kg than eel above this size) and US$ 247.35 / kg for trade with third parties. These prices agree well with data presented here from North Africa (Fig. 2).

Morocco banned eel fishing in the Mediterranean officially in 2005 but both glass eel and adult eel can be harvested from the Atlantic coast or indeed from inland waters [19]. The eel exported from Algeria and Tunisia, in contrast, must have originated from the Mediterranean or from inland waters. Prior to 2010 other countries, most notably Spain, had permission to fish in Moroccan waters and their catch was transported straight back to European harbours where it was landed [20,21]. Sabatié and Fontenelle [22] argued that most of the eel fishing in Moroccan waters was Spanish. It is not known if, and to what extent, especially Spanish fishermen land eel catches in Moroccan harbours. It is clear from seizure data in Hong Kong, mainland China, Bulgaria, Portugal and France [23,24] that European eel is illegally exported from or via Europe to East Asia. Indeed in the European Action Plan against Wildlife Trafficking [24] the large-scale smuggling of European eels is highlighted as “one of the most serious problems the EU currently faces as a source region for illegal export of wildlife..”. While it was believed that most of the trade involved direct exports from the main source countries (e.g. Spain, France, Portugal) Morocco was singled out as one of the neighbouring countries that has been, or is believed to be, used as a transit country.

It seems that the Japanese eel *A. japonica* is preferred above other eel species in many of the East Asian consumer countries, but that, in years when availability of this species is low, there are marked import shifts to other eels [13]. The dynamics of the eel trade reflect the true global nature of this trade, and when one species no longer becomes available due to falling stocks, lower levels of recruitment or an increase in demand from new consumer markets, other sources (with the same, similar or different species) will be found. When the Japanese eel

became less available European eel was a viable alternative, and East Asian countries initially obtained them mainly from EU countries. With the EU ban in place, countries like Indonesia and the Philippines were able to fulfil part of the East Asian demand, albeit by offering different species of eel [13,14], and North African countries, not bound by the EU ban, were able to supply the East Asian market with European eel. The contribution Morocco, Algeria and Tunisia make to the global trade is relatively modest; in 2013 Indonesia exported at least 6100 t to East Asia and the Philippines 1100 t [13,14] against some 225 t for Morocco, Algeria and Tunisia combined.

The EU countries were not able to conclude what quantities of eel can be caught and exported without it becoming detrimental to the survival of the species [10], but evidently Morocco and Tunisia were able to do so following the inclusion of the species on Appendix II of CITES. Furthermore, any change in fisheries in the southern part of the eel's range, both in the Atlantic Ocean and the Mediterranean Sea, can have an influence on populations further north and east. Further collaboration and synchronization of eel fisheries management decisions, such as the zero quota policy, between the EU and its African partners is needed. Both the Bonn Convention on the Conservation of Migratory Species of Wild Animals and the Bern Convention on the Conservation of European Wildlife and Natural Habitats would offer a potentially suitable framework for this [25]. Finally, as argued elsewhere for tropical eel species [14] it is imperative to start monitoring the global trade in European eel to a higher level of accuracy (including information on the various life stages such as glass eel, elvers and adults, or sizes as indeed available for the most recent years in Eurostat's Comext database [18]) from a wider range of countries (i.e. including non-EU range countries such as Morocco and Tunisia). The failure to do so, representative of a general inability of customs agencies and monitoring bodies to develop responsive methodologies appropriate for the many aspects of wildlife trade [26], could prove to be detrimental to an economically important species already facing a very high risk of extinction in the wild.

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