

Reviewing the trade in glass eels *Anguilla* spp.

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INTRODUCTION

The family Anguillidae, commonly referred to as freshwater eels, comprises 16 species, all in the genus *Anguilla* (Watanabe *et al.*, 2009). Various life stages of many *Anguilla* species, ranging from glass eel to silver eel (Fig. 1), are harvested and traded internationally for consumption, and the species are of significant commercial importance, in particular the European Eel *Anguilla anguilla*, the Japanese Eel *A. japonica*, and the American Eel *A. rostrata* (FAO, 2020). Wild juvenile eels (also called glass eels, elver or live eel fry) are caught and then used as “seed” in farming/aquaculture operations as captive breeding of *Anguilla* spp. is not yet commercially viable (Butts *et al.*, 2016; Kuroki *et al.*, 2019).

Farming operations predominantly occur in East Asia (the People’s Republic of China [hereafter China], Japan, the Republic of Korea [South Korea] and Taiwan, People’s Republic of China [Taiwan], with Hong Kong

Special Administrative Region (SAR) [Hong Kong] being an important trade hub for glass eels destined for farming operations in the region (Crook and Nakamura, 2013; Shiraishi and Crook, 2015). In the past, eel farming in East Asia predominantly relied on the Japanese Eel, which is native to the region; however, as catch of this species rapidly declined and the price dramatically increased, many Asian farms, especially those in China, began importing from the 1990s large quantities of other *Anguilla* spp., specifically *A. anguilla*, as seed for farming (Ringuet *et al.*, 2002; Shiraishi and Crook, 2015).

Populations of several *Anguilla* species have declined considerably over the last decades due to various threats including barriers in waterways, the loss of river habitat, pollution, changes in oceanic conditions, diseases and unsustainable exploitation. *Anguilla anguilla* is currently listed as Critically Endangered on the IUCN Red List of Threatened Species and *A. japonica* and *A. rostrata* are classified as Endangered (Jacoby and Gollock, 2014a; 2014b; Jacoby *et al.*, 2017). Concerns over the impact international trade was having on *A. anguilla* populations led to the species being listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 2007, effective March 2009. Since then, there have been significant changes in the global exploitation and trade of *Anguilla* spp. In addition to an ongoing illegal trade in *A. anguilla*, there has been increasing demand for other *Anguilla* spp. (Gollock *et al.*, 2018; Musing *et al.*, 2018). This article provides an overview of the international eel trade over the decades, focusing on changes in the trade dynamics of live glass eels, especially the species not native to East Asia but used for farming, and provides recommendations for decision-makers based on current and previous TRAFFIC eel trade research.

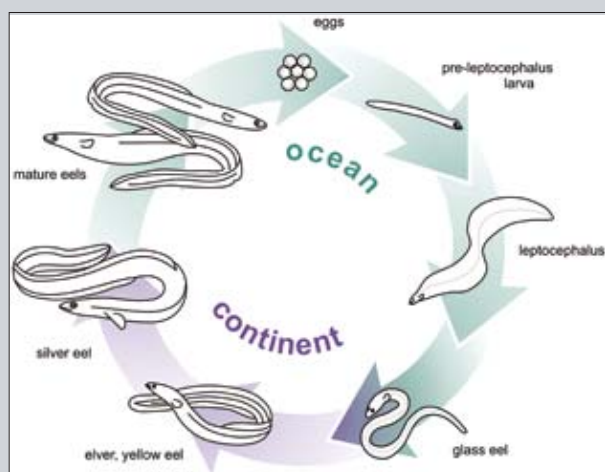


Fig. 1. Diagram of the life cycle of anguillid eels. Source: Henkel *et al.* (2012).

METHODS

Catch production and trade data for *Anguilla* spp. were collated from several sources to provide an overview of trade dynamics.

East Asia and other Customs data

Customs import and export data for *Anguilla* live eel fry for the East Asian countries/territories for 2004–2019 were obtained from the following sources:

- China Customs Information Centre (data requested via China Cuslink Co. Ltd. up to 2017; <http://43.248.49.97/indexEn> since 2018);
- Hong Kong Trade Development Council (<https://tradeids.censtatd.gov.hk>);
- Ministry of Finance, Trade Statistics of Japan (<http://www.customs.go.jp/toukei/info/>);
- South Korea International Trade Association (<http://www.kita.org/>); and
- Taiwan Bureau of Foreign Trade (<http://cus93.trade.gov.tw/ENGLISH/FSCE/>).

Globally, there is one six-digit Harmonised Systems (HS) Customs code designated for live *Anguilla* eels (HS 030192), however this code does not differentiate between the various life stages or species. All East Asian countries/territories have adopted more detailed eel Customs codes that differentiate between “live eel fry” for farming and “other live eel” for consumption purposes (except for Japan’s live eel export Customs code) from 2004 (Table 1); however, the definition of “live eel fry” varies between them. For example, “live eel fry” in Japan refers to glass eels and elvers 13 g or less per specimen, but in South Korea the term includes young eels up to 50 g per specimen. Furthermore, South Korea differentiates between two different sizes of eel fry (by weight) and Taiwan between three sizes (by pieces per kg). For this article, unless otherwise specified, the following terms apply:

- “live eel fry” refers to juvenile/young eels (irrespective of the size, including glass eels and elvers) used for farming; and
- “other live eel” refers to larger sized eels used for consumption (including large elvers, yellow and silver eels).

As species-specific Customs data are not available, geographic provenance was used to infer the likely

Anguilla spp. being traded and supplied to farms. For the purposes of analysis, it was assumed that countries/territories named in trade data as the origin of exports were the sources of live eel fry. Although several *Anguilla* spp. can be caught in one country/territory, *Anguilla* spp. from particular regions in the trade data were assumed to refer to the following species i.e. East Asia (*A. japonica*), Americas (*A. rostrata*), Southeast Asia (*A. bicolor* and other tropical species), Oceania (*A. australis*, *A. dieffenbachii* and *A. reinhardtii*) and East/Southern Africa (*A. mossambica* and other tropical species).

Hong Kong is sometimes described as the source of live eel fry in East Asian Customs data, which obscures their actual source as there are no glass eel fisheries or eel farms in Hong Kong (Agriculture, Fisheries and Conservation Department of the Hong Kong Special Administrative Region (AFCD), pers. comm. to TRAFFIC, November 2017) and these are re-exports. Imports from Hong Kong into the East Asian countries and territories (accounting for 17% of total weight between 2004 and 2019) were therefore excluded from the analysis into the origin of live eel fry. Of two types of import data (by origin and by supplier) available in Hong Kong, the origin data were used for this report, unless otherwise specified.

Information released regarding Informal Consultation on International Cooperation for Conservation and Management of Japanese Eel Stock and Other Relevant Eel Species

Information was also sourced from joint statements arising from annual meetings of the Informal Consultation on International Cooperation for Conservation and Management of Japanese Eel Stock and Other Relevant Eel Species attended by China, Japan, South Korea and Taiwan. China was absent from the meetings held between 2015 and April 2019—the most recent meeting—and data relating to farming and trade for China for this period is therefore missing. For example, data on live eel fry input into farms for 2004–2014 is available from http://www.jfa.maff.go.jp/j/saibai/pdf/140917unagi_data.pdf. “Input” is used to describe the supply of live eel fry into grow-out eel farms.



European Eel *Anguilla anguilla*



American Eel *Anguilla rostrata*

| | Customs Code | Commodity |
|-------------|-----------------|---|
| China | 0301.92.10.10 | Live eel fry of Marbled Eel <i>Anguilla marmorata</i> |
| | 0301.92.10.20 | Live eel fry of European Eel <i>Anguilla anguilla</i> |
| | 0301.92.10.90 | Live eel fry, other <i>Anguilla</i> spp. |
| | 0301.92.90.10 | Live eels, other than fry of <i>Anguilla marmorata</i> |
| | 0301.92.90.20 | Live eels, other than fry of <i>Anguilla anguilla</i> |
| | 0301.92.90.90 | Live eels, other than fry of other <i>Anguilla</i> spp. |
| Japan | 0301.92.10.0 | Live eel fry " <i>Anguilla</i> spp." (only used for imports) |
| | 0301.92.20.0 | Live eels, other than fry of <i>Anguilla</i> spp. (only used for imports) |
| | 0301.92.00.0 | Live eel of <i>Anguilla</i> spp. (only used for exports) |
| South Korea | 0301.92.10.00 | Glass eel (≤ 0.3 g per unit, for aquaculture) |
| | 0301.92.20.00 | Young eel (> 0.3 g and ≤ 50 g per unit, for aquaculture) |
| | 0301.92.90.00 | Live eels, other than fry of <i>Anguilla</i> spp. |
| Hong Kong | 0301.92.10 | Live eel fry " <i>Anguilla</i> spp." |
| | 0301.92.90 | Live eels, other than fry of <i>Anguilla</i> spp. |
| Taiwan | 0301.92.10.10-1 | Eels, <i>Anguilla japonica</i> , live |
| | 0301.92.10.20-9 | Eels, <i>Anguilla marmorata</i> , live |
| | 0301.92.10.90-4 | Other eels (<i>Anguilla</i> spp.), live |
| | 0301.92.20.10-9 | Glass eel ($\Rightarrow 5000$ pcs per kg) |
| | 0301.92.20.20-7 | Eel fry ($\Rightarrow 500$ and < 5000 pcs per kg) |
| | 0301.92.20.30-5 | Young eel (elver) (> 10 and < 500 pcs per kg) |
| | 0301.99.29.40-7 | Live Australian eels |

Table 1. Customs codes and descriptions of live *Anguilla* eels in East Asia (valid March 2020).

Note: mainland China uses 10-digit codes for tariff purposes (along with additional 3-digit China Inspection and Quarantine (CIQ) codes), but only 8-digit data (non-species-specific) are available for analysis. Sources: Editorial Department of the Customs Import and Export Tariff of China (2016); <http://www.transcustoms.com/>; Hong Kong Census and Statistics Department; Ministry of Finance, Trade Statistics of Japan; Korea International Trade Association; Taiwan Bureau of Foreign Trade.

Other information

Other data sources include IUCN Red List assessments, documents of relevant CITES meetings and published scientific papers identified using Web of Knowledge. Grey literature was identified using web searches especially when scientific papers were not available.

Global glass eel trade over the decades

A significant volume of *A. anguilla* glass eels was being caught in Europe, specifically France, by the early 1900s, destined locally or for Spain, reaching over 530 t in 1925 (Briand *et al.*, 2008). It was not until the late 1960s that *A. anguilla* glass eels started to be exported from Europe to East Asia. Glass eel landings and exports to that region increased due to a change in fishing practices, with exports reaching a peak of 1,200 t in 1976 (Briand *et al.*, 2008). According to Japanese Customs data, imports of live eel fry from France declined over the years to less than 10 t in 1987. Exports of glass eels from France to East Asia increased again in 1994 when eel farms in China, which had lower labour and running costs, were established (Briand *et al.*, 2008); glass eel exports to China reached 266 t in 1997, after which they decreased again to 78 t in 2000 (Ringuet *et al.*, 2002).

While the illegal fishing and trade of *A. anguilla* has sometimes been attributed to the CITES listing of the species, such practices were already being reported in Europe by the 2000s. In 1989, more than 30% (170 t) of glass eels were caught by non-professional fishers including amateurs and poachers (Castelnaud *et al.*, 1994) despite only a small amount of those caught by non-professionals allowed for sale (Casinière, 1996). De Bruyne *et al.* (2006) suggest 20 t of glass eels were caught by poachers in the 2000s.

In 2007, the EU adopted Council Regulation (EC) No. 1100/2007 (hereafter referred to as the EU Eel Regulation)¹ to ensure protection and sustainable use of *A. anguilla* which, *inter alia*, stipulated that relevant EU Member States should develop Eel Management Plans to ensure the recovery of stock across their territories. Furthermore, the species was listed in CITES Appendix II in the same year, effective March 2009. During the 2009–2010 glass eel fishing season—the first full fishing season after the CITES listing came into force—exports of glass eels were only permitted from EU Member States with approved management plans in place and export of glass eels was restricted to quotas set by the Scientific Review Group (EC, 2009). In fact, France was the only EU Member State to be allocated an export quota (14,230 kg), which was approved by the EC

¹Council Regulation (EC) No 1100/2007 <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32007R1100&from=EN>

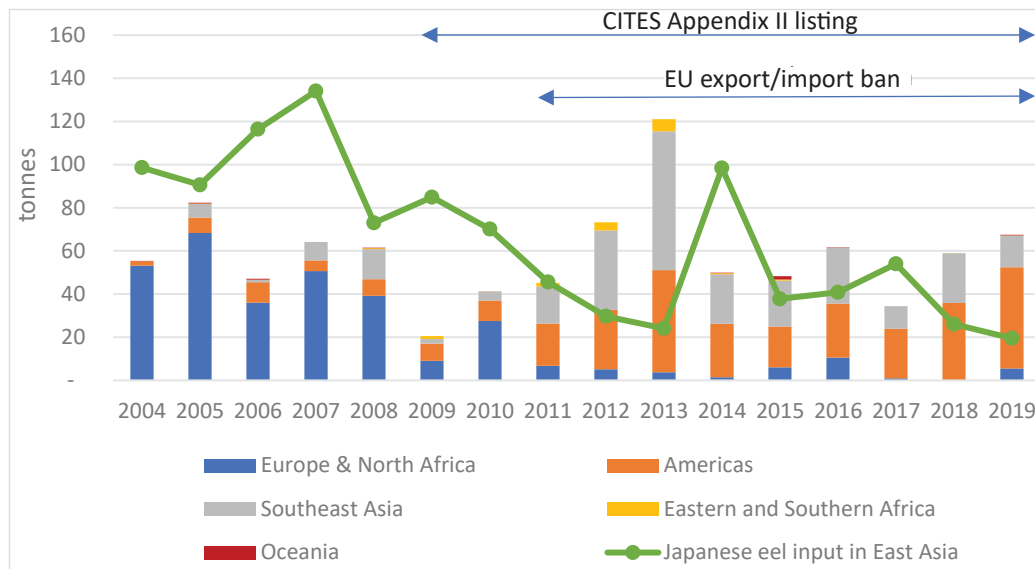


Fig. 2. Imports (t) of live eel fry for farming (all sizes) into East Asia (excluding trade between East Asian countries/territories) and the supply of *Anguilla japonica* for farming in East Asia, 2004–2019. Europe and North Africa (likely to be *A. anguilla*); Americas (likely to be *A. rostrata*); Southeast Asia (likely to be *A. bicolor* and other tropical *Anguilla* species); East/Southern Africa (likely to be *A. mossambica* and other tropical species); Oceania (likely to be *A. australis*). Note: supply of *Anguilla anguilla* for farming in East Asia was reported by fishing season; however, data for the 2018–2019 fishing season is, for example, recorded in the figure for 2019; supply of *Anguilla anguilla* for farming in East Asia in the 2013–2014 fishing season seems to have been overreported because of it being the base year to set input quota (Kaifu *et al.*, 2019). Sources: East Asian Customs; Anon. (2019a); Joint Press Releases of the East Asian eel meetings.

in February 2010; Spain and Portugal—other important glass eel catching countries—did not have their national management plans approved in time and the UK decided to ban temporarily all exports of glass eels caught in the UK, and Customs data suggest there may have been some illegal trade (Crook, 2010).

In December 2010, a zero-import/export policy was set for the EU, which remains in place, while harvest for internal (including within the EU) consumption/trade is still allowed. Despite this ban, East Asian Customs data indicate that glass eels were imported from EU Member States into East Asia every year until 2016, suggesting some may have been illegally exported. According to Customs data, East Asian countries and territories also began importing glass eels from North Africa in 2009, with reported trade reaching 4.5 t in 2016. Even though these countries do not permit the export of glass eels, at least in recent years (Musing *et al.*, 2018), imports from North Africa were reported by East Asian countries/territories up until 2019; it has been suggested that some of these glass eels may have originated in the EU and been transported through North Africa to avoid EU trade controls (Europol, 2018a). Annual imports of live eel fry into East Asia from Europe and North Africa (likely to be *A. anguilla*) accounted for 96% of all live eel fry imports from outside East Asia in 2004 with 53 t, which declined to 3% (1 t) in 2014, increasing again in 2016 (11 t, 17%).

There have also been significant changes in the trade in other *Anguilla* species over the last 15 years. According to East Asian Customs data, total East Asian imports of

live eel fry from non-*A. anguilla* range States gradually increased, reaching over 117 t in 2013 (including over 38.5 t of young eels in 2013) (Fig. 2). Increases in sourcing for these countries is likely to have been triggered for several reasons including the CITES listing of *A. anguilla* and considerably low input of *A. japonica* glass eels for farming in the 2011–2012 and 2012–2013 fishing season in East Asia (less than 30 t respectively) (CITES, 2018).

According to East Asian Customs data, imports of live eel fry from the Americas (likely to be *A. rostrata*) increased, with fluctuations from 2 t in 2004 to 47 t in 2013 (young eels accounting for more than 16 t) but slightly declined in the following years before increasing again to 47 t in 2019. Various sources suggest that *A. rostrata* from North America have been used for farming in China since the 1990s, but imports from the Caribbean and Central American countries have increased in the last few years due to the soaring price of North American glass eels and improved farming technologies for the Caribbean and Central American glass eels, which tend to be smaller than the former (Anon, 2018; Fan and Qin, 2016; Han, 2016). In addition to reported imports into East Asia from the Caribbean and Central American countries, which began around 2012, additional live eel fry caught in the region are being traded via the USA and Canada, but do not appear as such in origin/re-exporter data (Gollock *et al.*, 2018). According to the East Asian Customs data, all the East Asian countries and territories reported imports of *A. rostrata* over the last 15

years while the majority of live eel fry seems to have been imported via Hong Kong. On the other hand, imports of *A. bicolor* and other tropical species into East Asia seem to have declined after 2012; eel farmers do not seem to have strong interests in *A. bicolor* for the moment due to its low market price (Li, 2019) although uncertainties about interests and demand remain. Considerable levels of illegal trade, driven by the demand for farming, have been documented in many countries. For example, in the USA “Operation Broken Glass”—a multi-jurisdiction investigation—resulted in 19 people pleading guilty to illegal fishing and trade of elvers, which resulted in prison sentences and fines (U.S. Fish and Wildlife Service, 2019).

There still appears to be demand for *A. anguilla* despite the difficulties in sourcing this species and the increase in demand for other *Anguilla* spp. In recent years, European authorities have increasingly reported the involvement of organised criminal networks in the movement of legally and illegally sourced European glass eels from the EU to East Asia. During the 2015–2016 glass eel fishing season, Europol initiated Operation LAKE, a European initiative aimed at combating illegal eel trade and dismantling organised networks involved in associated illegal activities (Europol, 2017). Consequently, 4 t of live eel fry were seized and 48 persons arrested in the 2016–2017 fishing season, 3.4 t of live eel fry were seized in the 2017–2018 fishing season, and 5.8 t of live eel fry were seized and 154 people arrested in the 2018–2019 fishing season (Europol, 2017; 2018b; 2019). However, there remain uncertainties about the quantity of glass eels illegally exported/supplied to eel farms in East Asia (CITES, 2018). Recent seizure data in Europe and Asia suggest that *A. anguilla* specimens have been increasingly transported from Europe to Southeast Asian countries (Musing *et al.*, 2018).

DISCUSSION AND CONCLUSIONS

Trade data analysis of *Anguilla* spp. over the last 15 years shows that there have been substantial shifts in trade related to live eel fry. According to East Asian Customs data, annual imports of live eel fry from Europe and North Africa (likely *A. anguilla*) accounted for 96% of all live eel fry imports from outside East Asia in 2004, which declined to 3% in 2013, while imports from other regions increased from 2 t in 2004 to 38 t in 2011, reaching a peak of 112 t in 2013. The Americas and Southeast Asia became increasingly important live eel fry source regions for East Asian farms during this time. These fluctuations coincided with the CITES listing of *A. anguilla* coming into force in 2009, the banning of all trade in *A. anguilla* from, and to, the EU in 2010, and low harvest of *A. japonica* for four consecutive years during 2010–2013.

This shift in demand also seems to be closely related to the development of farming techniques for different *Anguilla* species/populations and the popularity as well

as availability and price of glass eels. While exports of *A. anguilla* from Europe to Asia (Japan at this time) declined once, they resumed in 1994 due to demand in China and lower labour and running costs, which made farming *A. anguilla* worth investing in (Briand *et al.*, 2008). Imports of *A. rostrata* from North America for farming trials started in China in 1994, and remained stable until early 2010s when imports from Central American countries to East Asia began due to the higher price of the species/populations which had been used and the development of farming techniques for *A. rostrata* glass eels from Central America (which are reportedly smaller than those from North America). The volume of *A. rostrata* live eel fry imports increased over the years, reaching over 20 t in the 2014–2015 fishing season onwards. While fisheries regulations are implemented in some *A. rostrata* range States (Gollock *et al.*, 2018), and considering changes in the trade dynamics in the last few years, further research into whether current fisheries and trade regulations are sufficient and fully implemented is needed, specifically in new and/or emerging source countries e.g. the Dominican Republic, Haiti and Cuba.

Although demand for *Anguilla* species from Southeast Asia and East/Southern Africa seem to have declined after the upsurge in the mid-2010s, it could increase again as was the case with *A. anguilla* and *A. rostrata*, when techniques are successfully developed and the availability of the other currently favoured *Anguilla* spp. declines. Although some Southeast Asian countries have already implemented trade regulations (e.g. an export ban for glass eels) and initiatives to enhance sustainable resource management have been undertaken, e.g. a project of the Southeast Asian Fisheries Development Centre (SEAFDEC, 2018), further strengthening of management measures and close monitoring of exploitation and trade would be warranted. For example, despite the export ban in the Philippines of *Anguilla* spp. of 15 cm in size or less since 2012, East Asian Customs data show that specimens likely below this size have been imported from the country every year up to 2019. In addition, East Asian countries and territories report a significant volume of imports of live eel fry from Southeast Asian countries where glass eel fishing or farming does not exist (e.g. Malaysia and Thailand) (Gollock *et al.*, 2018; SEAFDEC, 2018), some of which may play a role as a transit point.

Despite an increase in imports of other *Anguilla* spp. in East Asia, illegal trade in *A. anguilla* has continued, perhaps because of an apparent “ready supply” of glass eels in the EU. Although the stock has been depleted, some 58.6 t of glass eels were reportedly caught in the EU in 2018 (ICES, 2018) for example, and an additional unknown amount of glass eels are considered to be caught by IUU fishing each year. Although illegal export of glass eels from the EU is driven by demand for farming in East Asia, structural challenges of ensuring sustainability, legality and traceability in the EU have been pointed out, such as significant variation in management measures

taken by the different EU Member States, insufficient information exchange and the lack of a harmonised traceability system for *A. anguilla* within the EU (EC, 2020; Musing *et al.*, 2018). In fact, even though the EU Eel Regulation sets out a clear framework as to the Member States' obligations concerning traceability of *A. anguilla* trade within the EU, there is no EU-wide traceability system; once glass eels leave one country, the recipient EU Member State is unlikely to track the origin of these glass eels (Hanel *et al.*, 2019). ICES (2016) notes that more than 30% of glass eels were not traceable in the EU in 2015 and 2016.

Given that there is a considerable price gap between live eels traded in the EU and those offered in East Asia, illegal trade is likely to continue unless there are advantages to trade within the EU only and/or more stringent regulations and controls are introduced to prevent illegal fishing and trade. Specifically, introduction of an EU-wide traceability system for *A. anguilla* within the EU to ensure transparency in the supply chain, and data reliability and verification from catch to consumption, would be essential as the evaluation of the implementation of EU Eel Regulation published in early 2020 indicated, whether or not the EU import/export ban continues or imports/exports resume in the future. Along with revision of the Council Regulation (EC) No 1224/2009 (EU Fisheries Control Regulation), further actions would be needed to achieve this at the EU and Member States level by learning from other species and systems e.g. EU Trade Control and Expert System (TRACES).

Among other issues to be addressed is the lack of knowledge about farming practices in East Asia, including to what extent there is a trade-off between

A. japonica glass eel input for farming and other *Anguilla* spp. The 2011–2012 and 2012–2013 fishing season saw considerably low input of *A. japonica* glass eels for farming and a sudden increase in imports of new/emerging *Anguilla* spp. The 2018–2019 fishing season saw the second lowest input of *A. japonica* in East Asia over the decades (Anon., 2019) and reported imports of other *Anguilla* spp. for 2019 were 67 t, which was the highest since 2014, but much lower than in 2012 and 2013. A better understanding of farming practices and demand dynamics, regulatory and reporting framework for eel farming as well as trade of glass eels and farmed eels is vital to identify fundamental problems and to take a step towards more responsible use of the species.

Based on the most recent eel trade data and previous research, it is vital that the relevant authorities of source, transit, farming and consumer countries/territories of *Anguilla* spp. ensure regional and/or global co-ordinated adaptive management and conservation measures for *Anguilla* spp. are fully implemented in order to achieve sustainable use of all *Anguilla* species. Considering that changes in the availability of certain *Anguilla* spp. has led to an increase in demand for different *Anguilla* spp. over the last few decades, mechanisms to facilitate co-operation and co-ordination between source, transit, farming and consumer countries/territories targeting the whole *Anguilla* genus are essential. These mechanisms could include, but should not be limited to, a genus-wide CITES listing for all *Anguilla* spp. Other recommendations for the relevant authorities and NGOs from this analysis included:

- focus further research on eel farming practice, farming production and consumption quantities, and species used, especially in apparently emerging markets such as China and South Korea;
- focus further research on eel exploitation and trade especially in emerging and/or lesser-known transit/source countries such as Canada, Malaysia, Thailand and the USA;
- review the scale and dynamics of the global eel industry, trade and consumption from a financial/economic point of view, including but not limited to subsidies and other financial support to the eel fisheries and farming;
- maintain, extend and further strengthen multi-lateral and bilateral co-operation between exporting/transit/importing countries, in particular between enforcement agencies, to control imports of glass eels from countries/territories that have fishing/export restrictions in place;
- ensure traceability for glass eels including in cross-border trade e.g. by introducing an EU-wide traceability system for *A. anguilla*;
- raise awareness among eel industry, traders, retailers and consumers with regards to eel legality, traceability and sustainability issues.



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Top: juvenile European Eels *Anguilla anguilla*
Below: smoked eel on sale at Amsterdam Airport, Netherlands, February 2015.

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