



GLASS EELS:

ASSESSING SUPPLY CHAIN AND MARKET IMPACTS OF A CITES LISTING ON *ANGUILLA* SPECIES

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The various life stages of freshwater eels of the genus *Anguilla* are harvested and traded internationally for farming and consumption, with current demand predominantly driven by East Asian markets. Analysis of production and trade data suggests that harvesting, trade and consumption trends across the globe have changed since the listing of the European Eel *Anguilla anguilla* in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) came into force in March 2009. As part of a broader TRAFFIC study, this article provides examples of recent diversification of the sourcing of, and international trade in, juvenile eels for supplying eel farms in East Asia from three regions of the world.

GLASS EELS: PICTURE ALLIANCE / BERND SETNIK

INTRODUCTION

THE FAMILY ANGUILLIDAE, commonly referred to as freshwater eels, is composed of at least 16 species, all in the genus *Anguilla* (Silfvergrip, 2009; Watanabe *et al.*, 2009). *Anguilla* species are distributed throughout tropical and temperate waters, except for the eastern Pacific and south Atlantic (Silfvergrip, 2009). The various life stages of all *Anguilla* species are harvested and traded on a global scale for farming and consumption, although current demand is predominantly driven by East Asian markets, in particular Japan.

According to the Food and Agriculture Organization of the United Nations (FAO) data, global eel production has risen dramatically—from 17 750 t in 1950 (only 3% coming from aquaculture/farms) to 280 000 t in 2007 (96% from farms), after which production stabilized in 2008 to 2010 (FAO, 2012). Eel farming, which is now responsible for nearly all *Anguilla* production worldwide, is reliant on wild-caught juvenile eels (also called glass eels or “live eel fry”) owing to the, as yet, limited success in reproducing these species in captivity for commercial purposes (Tsukamoto, 2012). The majority of eel farming occurs in mainland China, Taiwan, Japan and the Republic of Korea, with juvenile eels being caught in territorial waters or imported from further afield to supply these farms. In addition, Hong Kong Special Administrative Region is an important international trade hub for juvenile eels destined for farming in this region.

Prior to 1990, eel farming was almost exclusively carried out using species of local provenance: Japanese Eel *Anguilla japonica* in Asia and European Eel *Anguilla anguilla* in Europe. However, a decline in *A. japonica* stocks and recruitment, and the relatively abundant supplies and lower price of *A. anguilla* glass eels led to many Asian eel farms, in particular those in mainland China, switching to *A. anguilla* for their culture material at the end of the 1990s (Ringuet *et al.*, 2002). With further declines in both *A. japonica* and *A. anguilla* stocks in recent years, the market for glass eels has continued to evolve, and new populations and *Anguilla* species such as American Eel *Anguilla rostrata* from the Americas, African Longfin Eel *Anguilla mossambica* from Africa and Giant Mottled Eel *Anguilla marmorata* from South-east Asia are now being exploited to supply East Asian farms with glass eels.

Wild populations of *Anguilla* species have declined considerably over the last 30 years owing to several factors, including fishing for trade (Dekker *et al.*, 2009). Due to concerns that trade was having a serious impact on European Eel populations in particular, this species (currently listed as Critically Endangered on the IUCN Red List (Freyhof and Kottelat, 2008)) was proposed for listing in CITES Appendix II in 2007. The listing came into force in March 2009. International trade in Appendix II-listed species is permitted provided authorities are satisfied that such trade will not be detrimental to the survival of the species in the wild. In December 2010, European Union (EU) Member States concluded that

they were unable to verify this, and, combined with deep concerns over the status of the species, decided to suspend all exports and imports of *A. anguilla* commodities from and to the EU. Trade in *A. anguilla* between non-EU CITES Parties, and also within the EU, however, is still permitted.

Although only trade in *A. anguilla* is regulated through CITES, there are concerns over the impact that international trade may be having on other *Anguilla* species, in particular *A. japonica*, *A. rostrata* and the lesser-known tropical *Anguilla* species. Furthermore, controlling trade in just one *Anguilla* species through CITES and the stricter measures imposed by the EU is likely to have altered global eel trade dynamics and exploitation patterns, in particular for the high value commodity, glass eels.

METHODS

TRAFFIC routinely reviews a number of information sources in order to monitor any changes in both legal and illegal eel trade patterns and to identify emerging trends. These include Customs data from historically important importing and exporting countries/territories; global production (capture and aquaculture) and trade data collated by FAO; online advertisements on Business to Business (B2B) marketplaces/trade platforms such as Alibaba, Food and Beverage Online, Weiku, EC21 and Trade Key; CITES trade data; press releases and literature reviews.

Customs data from East Asian countries/territories, in particular, are useful when researching trade in different life stages of live *Anguilla* eels, as they record trade in “live eel fry” destined for farming, in addition to larger “live eel” destined for direct consumption. Since 2012, the EU has also introduced new Customs codes for various sizes of live eels in trade (see Table 1), however, most other countries/territories only report trade in *Anguilla* species to the genus level, under the four main commodities—live, fresh, frozen and smoked/prepared (see Crook, 2010).

It should be noted that variation in reporting methods used by different countries/territories, lack of availability of species-specific data and mis-reporting, are just some of the factors that can lead to difficulties in reaching unequivocal conclusions. Despite these issues, freely available trade and production datasets are important sources of information, at the very least facilitating a better understanding of the complexities of global patterns in eel trade and consumption and can provide an indication of possible problems, such as illegal trade.

Due to the delicate nature of glass eels and the speed with which they must reach their destination to avoid considerable mortality, it can generally be assumed that the country of export is the origin of such shipments. Therefore, for this specific commodity, geographic provenance can be used to identify the likely *Anguilla* species in trade. In the examples that follow, official national trade statistics are the source of the information, unless otherwise specified. Import/export figures are based on countries'/territories' respective Customs data.

EXAMPLES OF RECENT DIVERSIFICATION OF SOURCING JUVENILE EELS FROM THREE REGIONS OF THE WORLD TO SUPPLY EEL FARMS IN EAST ASIA:

Americas (with a focus on the USA, Canada and Dominican Republic)

Only one *Anguilla* species is known to live in the waters of the Americas: *A. rostrata*. This species is found along the Atlantic coast of the USA and Canada, and ranges as far south as the northern coast of South America, encompassing the waters of the Caribbean. *Anguilla rostrata* has not yet been evaluated under the IUCN Red List criteria, but is currently “under review” for listing as threatened under the US *Endangered Species Act* of 1973 (USFWS, 2011). In April 2012, the US Fish and Wildlife Service announced that it was considering submitting a CITES listing proposal for *A. rostrata* (USFWS, 2012), however no proposal was submitted. In May 2012 the Atlantic States Marine Fisheries Commission (ASMFC) concluded that the *A. rostrata* stock was depleted (ASMFC, 2012).

The USA and Canada have exported *A. rostrata* glass eels to the principal East Asian eel farming countries/territories in small, irregular quantities for a number of decades. Between 1998 and 2010, live eel fry imports from *A. rostrata* range States into mainland China and Hong Kong ranged from 0.1 to 10 t per year, and from 2003, the main source of *A. rostrata* switched from the USA to Canada. However, between 2010 and 2011 there was a sudden leap in Asian imports from both countries: combined imports increased from just under 10 t in 2010 to over 50 t in the first six months of 2011 alone (see Fig. 1).

This sudden change in export quantities coincided with the EU’s decision at the end of 2010 to ban exports of European Eel. US Customs export data and press releases suggest that exports of *A. rostrata* glass eels were equally high in 2012 or increased even further (Trotter, 2012); for the first time in over ten years, Japan also imported live eel fry directly from the USA in 2012. Maine and South Carolina are the only two US States that allow commercial fishing of juvenile eels, however considerable levels of poaching and illegal trade, driven by the ever increasing prices offered for this commodity, have been reported from several States (Anon., 2012a).

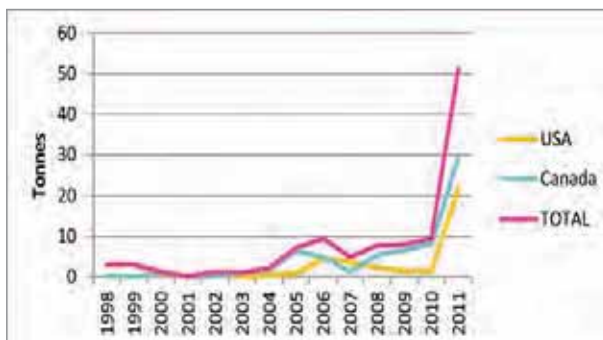


Fig. 1. Imports (tonnes) of *Anguilla* “live eel fry” into mainland China, Hong Kong, Taiwan, Republic of Korea and Japan from the USA and Canada, 1998–2011.

Sources: Asian national trade statistics

Of the more southerly range States of *A. rostrata*, the Dominican Republic has also recently started exporting glass eels to Asia for farming. Research into the status and biology of some of the *A. rostrata* populations of the Caribbean was carried out in the late 1990s (Tzeng *et al.*, 1998), with the aim of determining potential for export to Asian farming operations, and has commenced again in recent years (Anon., 2013a).

Trade data and online forums provide little evidence of any trade from the Caribbean in the last ten years, however, in 2011 Dominican glass eel fishermen placed advertisements online, requesting help to export glass eels (EspaceAgro, 2011) and in 2012, the Republic of Korea reported its first-ever import of live eel fry (250 kg) from the Dominican Republic. A US-based Asian-owned company advertises setting up camps along the US coast and in the Caribbean to harvest and export glass eels to Asia (Glass Eel Farm, 2012). However, at present only two companies (of 34 companies that applied for permits) are authorized to harvest glass eels in the Dominican Republic and illegal harvesting and trade via Haiti has become an issue of considerable concern to Dominican authorities (Anon., 2013b).

Africa (with a focus on Morocco and Madagascar)

African waters are home to six known *Anguilla* species: *A. anguilla*, *A. mossambica*, *A. bengalensis*, *A. bicolor*, *A. marmorata* and *A. nebulosa*. *Anguilla anguilla* is found only in North Africa, *A. mossambica* is endemic to the East African coast and the waters of Madagascar, and the latter four species are found both in African and Asian waters. *Anguilla bengalensis*, *A. bicolor*, *A. marmorata* and *A. nebulosa* are all currently listed as Least Concern on the IUCN Red List, based on their wide distributions. However, very little is known about the status of their populations, threats and harvest levels. Local declines of *A. marmorata* in Réunion Island and Madagascar due to habitat conversion and overfishing have been reported and there are concerns over possible future impacts of over-exploitation driven by the international market (Vishwanath and Mailautoka, 2012).

Various life stages of *A. anguilla* are harvested, farmed and exported from Algeria, Egypt, Morocco and Tunisia. Until recent years, exports were mainly destined for the European market. However, as imports into the EU of *A. anguilla* from non-EU range States have not been permitted since December 2010, North African countries have looked for alternative markets for their *A. anguilla* products. In addition, in the case of glass eels, with Asian demand for *A. anguilla* no longer being met by exports from the EU, a shift to direct imports into East Asia from North Africa has occurred. Hong Kong imported live eel fry (800 kg) from Morocco for the first time in 2009; in 2010, over 4500 kg were imported into mainland China and Hong Kong, and in the first six months of 2011 over 2000 kg were imported, including for the first time into the Republic of Korea (according to Asian Customs data from the late 1990s onwards).

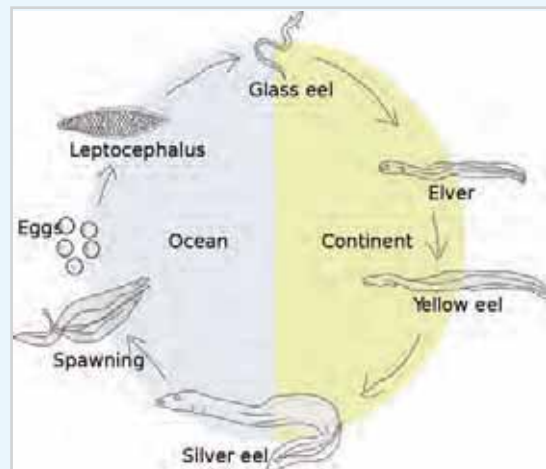
Records of imports of live eel fry into Asia from Madagascar stretch back a little further—since 2005 they have been fluctuating from 20 kg to nearly 1400 kg

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The life cycle of *Anguilla* species can be divided into five main stages:

1. eggs and leptocephali (larvae) carried inshore from marine spawning sites on currents;
2. “glass eels” (clear juveniles) reaching the continental shelf and estuaries;
3. “elvers” (pigmented juveniles) reaching freshwater habitats;
4. “yellow eels” living in freshwater habitats; and
5. adult or “silver eels” living in freshwater/estuaries before returning to the sea to spawn.

Source: Silfvergrip, 2009



Life cycle of eel, drawing by Salvör Gissurardóttir

The terms “glass eels” and “elvers” are often used interchangeably, for example, elvers is the common term for all juvenile eels in the USA, Canada and the Philippines. Glass eels of the European Eel, as defined in the European Union, are those measuring less than 12 cm in length (EC, 2009), and one kilogramme of European glass eels contains approximately 3000 individuals. Japanese glass eels, for example, however, tend to be smaller, with some 5000–6000 individuals per kilogramme (Ringuet *et al.*, 2002).

Glass eels are predominantly harvested in order to supply eel farms with “seed” for growing out; however they are also consumed directly in some countries, such as in Spain. Fishing is generally carried out at night in coastal and estuarine habitats, using various types of fine mesh nets, including conical/funnel shaped and hand held dip nets. However, in some countries, such as France, more intensive fishing practices including trawling are used, which lead to higher glass eel mortality due to their delicate nature (Ringuet *et al.*, 2002).



Fishing for glass eels for export to Japan.
Union River, Ellsworth, Maine, USA.

CAROL BLYBERG

	Customs Code	Commodity
International *	0301.92.00	Live eels “ <i>Anguilla</i> spp.”
European Union	0301.92.10	Live eels “ <i>Anguilla</i> spp.”, of a length of <12 cm
	0301.92.30	Live eels “ <i>Anguilla</i> spp.”, of a length of =>12 cm but < 20 cm
	0301.92.90	Live eels “ <i>Anguilla</i> spp.”, of a length of => 20 cm
China/Hong Kong/Korea**	0301.92.10	Live eel fry “ <i>Anguilla</i> spp.”
	0301.92.90	Live eels, other than fry (<i>Anguilla</i> spp.)
Japan	0301.92.10	Live eel fry “ <i>Anguilla</i> spp.”
	0301.92.20	Live eels, other than fry (<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 (>5000 pcs per kg)
	0301.92.20.20.7	Eel fry (>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. Harmonized system and combined nomenclature Customs codes for live *Anguilla* eels, 2012.

* Used in most countries/territories, unless more specific codes are available, as described in the table.

** Mainland China, Special Administrative Region of Hong Kong and Republic of Korea

GLASS EELS - PETER WOOD

per year, with the majority being imported into Hong Kong. Imports into the Republic of Korea commenced with 300 kg in 2011 and increased to over 700 kg in 2012, and in 2012 a small quantity of Malagasy glass eels (30 kg) were imported into Japan for the first time. Investment into sustainable fisheries and farming of eels in Madagascar and Mauritius, in particular of *A. mossambica*, has been reported in recent years (FIS, 2010) and various Malagasy companies are now offering live eels for sale via B2B marketplaces/trade platforms such as Alibaba. In 2012, the press reported the intentions of a Japanese company to import one tonne of live *A. mossambica* from Madagascar every week for half the price of eels cultivated in Japan, in order to help the industry fulfil consumer demand (Anon., 2012b).

Asia (with a focus on the Philippines)

Eight species of *Anguilla* are known to inhabit Asian waters: *A. japonica*, *A. borneensis*, *A. celebesensis*, *A. luzonensis*, and the four species also found in East Africa. *Anguilla japonica* is the most researched of the Asian species due to its historical importance in East Asian culinary traditions and being endemic to the waters of the principal Asian eel farming and consuming nations/territories. Although not currently evaluated on the IUCN Red List, in February 2013 it was listed as Endangered on the Japanese National Red List, based on recent ecological studies and catches indicating that there has been a 70–90% decline in the species over the last three generations (Anon., 2013c). *Anguilla luzonensis* was newly described in 2009, after being discovered in the waters of northern Luzon in the Philippines (Watanabe *et al.*, 2009).

In addition to looking for alternative *Anguilla* species from other continents around the world, eel farms in mainland China, Taiwan, Republic of Korea and Japan have increasingly been looking to other Asian countries for harvesting relatively under-exploited populations of *A. japonica* and other Asian *Anguilla* species, in particular the Philippines. According to Customs data, the Philippines has intermittently supplied East Asian

farming operations with live eel fry since the late 1990s, however only from 2005 were yearly imports to mainland China, Hong Kong and Taiwan reported. Although fluctuating considerably between 2005 and 2012, imports from the Philippines averaged six tonnes per year during this period. Reported imports of live eel fry from the Philippines to the Republic of Korea over recent decades amounted to a few kilogrammes (35 kg between 1998 and 2010), until in 2011 and 2012, 350 kg and over three tonnes were imported, respectively.

The increase in importance of the Philippines as a supplier of glass eels for East Asian farming operations also became apparent from online B2B marketplaces/trade platforms such as Alibaba, where over the last two years the majority of offers for sale of “glass eels” and “eel fry” were from companies offering eels originating in the Philippines. Several of these companies indicated that they could supply hundreds of kilogrammes of glass eels of a variety of eel species for export every month, including the newly described endemic species *A. luzonensis*.

In 2011, entire families—traditionally non-fishers—made the most of the high prices on the export market by camping alongside the coastal towns of Cagayan (Luzon) to catch *Anguilla* glass eels (De Yro, 2012). Concerns over considerable increases in exploitation of eel populations led the Philippines Government to ban commercial exports of juvenile eels in May 2012 (BFAR, 2012). Following the ban, young eels continued to be traded illegally. In September 2012, 13 boxes of live eel fry bound for Taiwan were intercepted at Ninoy Aquino International Airport (Anon., 2012c), while in July, 949 kg were found being smuggled onto a flight bound for Hong Kong (Santos, 2012). In July 2012, TRAFFIC surveys found almost 50 listings from businesses in the Philippines still offering eel fry or glass eels for sale through online B2B platform Alibaba. After TRAFFIC contacted Alibaba about these potentially illegal exports, the company removed the suppliers’ advertisements from its website and has agreed to try and prevent future listings of eel fry from the Philippines (TRAFFIC, 2012). In October 2012, the Bureau of Fisheries and Aquatic Resources (BFAR) reported a significant decrease in the market price as a result of the ban, and that this was anticipated to lead to a reduction in harvesting pressures (De Yro, 2012).

DISCUSSION

Although the majority of global eel production is derived from farming operations, until considerable progress is made in relation to captive reproduction of eels, such farming will be reliant on juveniles sourced from the wild. Despite reductions in the availability of glass eels from more traditional source countries in Europe and East Asia, according to FAO data, global production has remained stable since 2007. Consequently farm production is being supplied by glass eels derived from new or previously lesser-exploited *Anguilla* populations around the world. A concerning pattern of exploitation is already apparent: when one species or population becomes over-exploited, industry moves to the next



Giant Mottled Eel *Anguilla marmorata*, in the shallows, Kavieng, Papua New Guinea.

JURGEN FREUND / WWF-CANON



EELS FOR SALE IN TSUKIJI FISH MARKET, TOKYO (left, right); EEL DISHES ON SALE IN JAPAN (centre).

in order to supply farms with their stock. The limited availability and soaring prices of live eel fry have also led to considerable enforcement problems, with illegal harvesting and trade in a number of *Anguilla* species known to be occurring.

Increased exploitation and illegal exports of more vulnerable and poorly-understood tropical eel species/populations, such as those found in the Philippines, are of particular concern. In order to ensure that these populations do not follow a similar decline in conservation status as that of *A. anguilla* and *A. japonica*, further research into population numbers, harvesting and trade levels, habitat threats and management measures in place for these species is urgently needed.

The IUCN/SSC Anguillid Specialist Sub-Group (ASSG), of which TRAFFIC is a member, was formed in February 2012 in recognition of this need. The group brings together eel experts from across the world and one of its first tasks is to collate all available information on this genus in order to carry out accurate Red List assessments. Once all *Anguilla* species have been evaluated against the IUCN Red Listing criteria, this will considerably facilitate decision-making in relation to their use and conservation. Furthermore, it will be the first attempt to ensure all available information for each species is collated and will increase accessibility to such data and research for all stakeholders.

This article highlights some of the more dramatic shifts in harvesting and trade patterns related to glass eel supplies for farming that have been identified by TRAFFIC in recent years. However, developments in other regions and in relation to other eel commodities are also known to be ongoing, in addition to changes in consumption patterns. Japan has traditionally been the principal consumer of eel commodities worldwide, however analysis of recent global FAO production data and Japanese catch, farming and trade data suggests Japan's importance as a consumer may be decreasing. According to these data, in 2002 67% (150 t) of global eel production (220 t) was consumed in Japan. This percentage gradually decreased over the next eight years owing to decreases in imports from other farming nations, and in 2010 Japan appeared to be consuming only 27% (75 t) of global eel production (280 t). In support of this downward trend, the Japanese media has reported over

50 eel restaurants closing across Japan in the first half of 2012, due to high prices reducing consumer demand (Anon., 2012d). With Japanese consumption reportedly being such an important driver of the global eel market in the past, it is essential that further research into these changes be conducted and that the implications of any shifts in the distribution of demand between countries or regions are established.

Currently, trade in only one *Anguilla* species is regulated through CITES and generic Customs codes are still being used by the majority of trading nations to report trade in all life stages and eel species as a group. As such, precise knowledge of the global dimensions of trade in other *Anguilla* species, essential for resource management, is lacking. However, despite these limitations, there is considerable evidence that global eel consumption and trade dynamics is constantly evolving and affecting new species and populations across the globe. International co-operation for the management and conservation of all *Anguilla* species is therefore imperative.

It is hoped that further research, such as that being carried out by members of the IUCN/SSC Anguillid Specialist Sub-Group, will facilitate future decision-making in relation to international conservation, management and trade measures, including the case for listing additional, or all, *Anguilla* species, in the CITES Appendices. In the meantime, however, fostering international co-operation for the conservation and sustainable use of eels is essential and there are already a number of endeavours under way: the Sustainable Eel Group (a Europe-wide organization composed of conservation, science, government and industry partners), the East Asia Eel Resource Consortium and a framework for trilateral co-operation to conserve shared eel resources agreed by Japan, mainland China and Taiwan in 2012 (Anon., 2013d).

Collaborative and integrated eel management efforts such as these are vital to the future conservation of this ecologically and commercially important group of species.

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