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Anguilla anguilla, European eel

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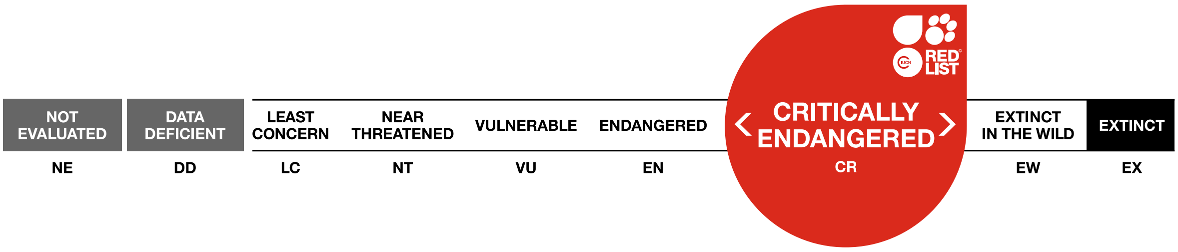

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Taxonomy

Kingdom	Phylum	Class	Order	Family
Animalia	Chordata	Actinopterygii	Anguilliformes	Anguillidae

Scientific Name: *Anguilla anguilla* (Linnaeus, 1758)

Synonym(s):

- *Muraena anguilla* Linnaeus, 1758

Regional Assessments:

- Europe
- Northern Africa

Common Name(s):

English:	European eel

Taxonomic Source(s):

Eschmeyer, W.N. (ed.). 2014. Catalog of Fishes. Updated 10 March 2014. Available at: http://research.calacademy.org/research/ichthyology/catalogfishcatmain.asp.

Taxonomic Notes:

Other *Anguilla* species have occasionally been stocked in Europe, but none have established a self-sustaining population. Pure *A. rostrata* (American Eel) have been recorded but are relatively rare (Boëtius 1976). Stocking attempts are likely to have caused this (Frankowski *et al*. 2008, Marohn *et al*. 2014). DNA analysis is the best tool to distinguish between the European Eel and other species (e.g. Frankowski *et al*. 2008), but *A. rostrata* have fewer vertebrae than *A. anguilla* (102–112, usually 106–108, vs. 111–119, usually 114–116). Hybrids have been found as larvae in the Sargasso Sea (Als *et al*. 2011, Pujolar *et al.* 2014*a*) and as yellow eels in Iceland where pure *A. rostrata* and *A. anguilla* also exist (Albert *et al*. 2006).

Assessment Information

Red List Category & Criteria:	Critically Endangered A2bd+4bd ver 3.1
Year Published:	2020
Date Assessed:	November 7, 2018

Justification:

Anguilla anguilla exhibits facultative catadromy (Tsukamoto *et al.* 1998, Tzeng *et al*. 2000, Tesch 2003), has multiple life stages, and is semelparous (Tesch 2003) and is panmictic across a continental spatial scale (Als *et al*. 2011, Pujolar *et al*. 2014*b*); these life history traits and characteristics made application of the IUCN Red List criteria challenging. Anguillids are often referred to as 'freshwater eels', however, it is known that they can exhibit inter-habitat migration and that a proportion may stay in estuaries, lagoons and coastal waters, rarely, if ever, entering freshwater.

The IUCN Red List criteria prioritise indices of mature animals at their breeding area. In the absence of such data for the eel, the criteria would be applied to silver eels starting their spawning migration (in the case of European Eels, leaving 'continental' waters), as these represent the maximum estimate of (pre-) spawning stock biomass, but such data sets for migrating silver eel are low in number, spatially limited and only recent (most only since 2010). The index data best representing the geographic range of *A. anguilla,* over adequate time scales to apply the Red List criteria*,* relate to glass eels, but the relationships between recruitment, yellow eel populations, silver eel escapement and spawner stock biomass are poorly understood (Westerberg *et al*. 2018). While there are hypotheses that certain regions may have greater importance for the spawning stock (e.g. Dekker, 2004, Kettle *et al*. 2011), evidence is lacking to support such hypotheses and to deviate from the common view that the European Eel is a panmictic species, i.e. all individuals come from a single spawning stock. As such, escapement from a specific river/country/region will not be directly reflected in subsequent recruitment as this relies on the spawning stock as a whole, irrespective of escapement location. Furthermore, it is most precautionary to assume that each and every part of the continental distribution area potentially contributes to the reproductive process, or that each part may be the key part (Dekker 1999). Therefore, the IUCN Red List criteria have to be applied to an amalgamation of multiple life stages, which provides the most comprehensive estimate.

Yellow and silver eel data for *A. anguilla* have an uneven geographical spread and do not fully represent the stock across its range. Nevertheless, a cursory analysis of these data found that over three generation lengths (39 years; see Habitat and Ecology), the mean decline in yellow and silver eels was found to be greater than 50% (see Population). Both analyses on yellow and silver eels indicated declines within the range of Endangered (EN) category.

Compounding these declines in escapement of maturing eels, are strong correlations between recruit series from sites over the range showing substantial declines during the period of the last three generations (Bornarel *et al*. 2018). The ICES recruitment index is 98.6% lower in the 'North Sea' series, and 94% lower in the 'Elsewhere' series, compared to the 1960–1979 reference level (ICES 2019*a*). It is noted, however, that the most recent statistical analyses conducted on these recruitment data have shown the trend from 2011–2019 has increased significantly from zero (ICES 2019*a*). Due to the period of time eels spend feeding and growing prior to silvering and migrating to spawn, the numbers of silver eels may continue to decline, reflecting past declines in recruitment.

Sampling for leptocephali in the Sargasso Sea was undertaken in 2011, and results compared with previous sampling across the same area occurring in 1983 and 1985 (Hanel *et al*. 2014). The reduction in catch rate was 89% between 1983 and 2011, and 64% between 1985 and 2011 (Hanel *et al*. 2014). This observation indicates a decrease in the abundance of leptocephali occurring in the Sargasso breeding grounds over this time period, suggesting a lower abundance of spawners, higher egg and/or larval mortality and/or a reduction in spawning success. Thus, data on leptocephali and recruits to continental waters indicate declines within the range of Critically Endangered (CR).

A suite of threats have been implicated in the decline of European Eel recruitment and stock: barriers to migration – including damage by hydropower turbines and pumps; climate change and/or changes in oceanic currents; disease and parasites (particularly *Anguillicola crassus*); exploitation of glass, yellow and silver eels; changing hydrology; habitat loss; pollutants; and predation. The significance of these threats individually or synergistically may vary across spatial range of the eel. Further research is required to fully quantify and understand the complexities of individual and combined threats.

Eel Management Plans (EMPs) have been developed in European Union Member States after implementation of the EU Council Regulation No 1100/2007 relating to the recovery of the European Eel (EU 2007). The Regulation set the objective of each EMP to be to “reduce anthropogenic mortalities so as to permit with high probability the escapement to the sea of at least 40 % of the silver eel biomass relative to the best estimate of escapement that would have existed if no anthropogenic influences had impacted the stock” (EU 2007), and that EMPs would be prepared with the purpose of achieving this objective in the long term.

A number of management measures are being implemented in line with EMPs, including control of fisheries, bypassing turbines and pumps, easing of barriers and restocking - transfer of eel from one watershed to another. Quantifying the effects of these measures on silver eel escapement biomass is complicated in many cases because (i) measures are not implemented in isolation, making it difficult to identify individual contributions, and (ii) measures affecting earlier life stages will take years to influence silver eels, and ultimately spawning stock. There remains a great deal of debate as to whether restocking benefits the eel spawning stock and thus enhances future recruitment. Regulations and management actions currently focus on increasing escapement from continental waters, although these do not take account of eel condition or quality (Belpaire *et al*. 2019).

A recent evaluation of the implementation of the Eel Regulation sought to assess the measures established for the protection and sustainable use of the European Eel stock, as well as the contribution of EMPs to promoting recovery (European Commission 2019, 2020*a*). It was concluded that the Regulation has been important in catalysing activity towards the recovery of the European Eel and remains a relevant document (European Commission 2020*b*). However, despite progress, the eel remains in a critical condition and recovery could take decades, and further ambition is required (European Commission 2020*b*).

Although the Eel Regulation (1100/2007) only applies to EU Member States, efforts are being pursued to non-EU countries to develop and implement management plans and conservation measures. The GFCM are currently in the process of negotiating a regional Eel Management Plan (SAC 2018). The last working group on the management of European eel (WGMEASURES-EEL) occurred on the 16–17th April 2019, where priorities for a regional research programme on eels was discussed, which included drafting an agreed workplan, with a method to launch and implement the programme (SAC 2019). A number of other range states have implemented management measures and/or developed national eel management plans (Musing *et al*. 2018).

In 2007, *A. anguilla* was listed in Appendix II of CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) due to concerns over the impact of international trade on this species (this listing came into force in March 2009). In 2010, the EU’s Scientific Review Group (SRG) concluded it was not possible to perform a Non-Detriment Finding (NDF) for this species (Musing *et al*. 2018). Exports out of, and imports into, the European Union (EU), have since ceased due to ongoing concerns over the decline in recruitment and stocks. However, trade continues within the EU and from non-EU countries within its range to other non-EU countries. In 2014, *Anguilla anguilla* was also listed in Appendix II of the Convention on Migratory Species (CMS).

The limited understanding of the complex relationship between recruitment, growth phase, and escapement makes it difficult to determine how declines in one will affect the other. However, it has been concluded that low recruitment will very likely ultimately translate, though not linearly, to reduced future escapement for, at least one generation length (13 years; see Habitat and Ecology). Further, since there is a short time period (~two years) between spawning and subsequent glass eel abundance, low recruitment has been proposed to be indicative of low breeding stock. As such it was deemed appropriate to assign *A. anguilla* a Critically Endangered (CR) listing under current observations and future projected reductions of mature individuals (A2bd+4bd).

This category status remains unchanged from the previous assessment. Ultimately the CR category accounts for a proportional decline in population over a continental scale and this species has undergone a substantial decline over the last three generations. Although implementation of management measures has shown improvement, there is still concern over the effectiveness of EMPs to generate recovery to historic reference state within an appropriate timeframe, in the context of multiple threats (European Commission 2020). Continued, and ideally increased, effort will be essential in promoting recovery. A drive to fill data gaps – particularly in relation to the southern range of this species – would allow a more spatially comprehensive assessment in the future.

Assessment of this species was carried out during a workshop held at the Zoological Society of London from the 5th–9th November 2018.

Previously Published Red List Assessments

2014 – Critically Endangered (CR)
https://dx.doi.org/10.2305/IUCN.UK.2014-1.RLTS.T60344A45833138.en

2010 – Critically Endangered (CR)

2008 – Critically Endangered (CR)

2006 – Not Evaluated (NE)

Geographic Range

Range Description:

Anguilla anguilla occurs in most inland waters of Europe and is distributed from North Cape in northern Norway, southwards along the coast of Europe, all coasts of the Mediterranean and on the North African coast (Schmidt 1909, Dekker 2003*b*). It very rarely enters the White and Barents seas, but it has been recorded eastward to the Pechora River in northwest Russia. The species occurs in low abundance in the Black Sea region where it migrates east to the Kuban drainage (occasional individuals reach the Volga drainage through canals). *Anguilla anguilla* also occurs in northern Scandinavia and eastern Europe. A report by the ICES Study Group on Anguillid Eels in Saline Waters (SGAESAW) indicates that eel stocks can contain a mix of freshwater residents, saline water residents, and inter-habitat migrants (ICES 2009). The continental distribution of the European Eel is over an area of approximately 90,000 km² in Europe and parts of North Africa (Moriarty and Dekker 1997), with a substantially larger range if their marine distribution is considered.

For several decades prior to a cessation of import to, and export from, the EU in 2010, *A. anguilla* was also exported to Asia for seed stock in eel farms (Ringuet *et al*. 2002). This species may well have been introduced in some parts of Asia (through escape or release from farms, e.g. Arai *et al*. 2017), however these will not contribute to the spawning stock and therefore areas of introduction have been excluded in the range information.

Anguilla anguilla are thought to spawn in the Sargasso Sea in the West Central Atlantic between late winter and early spring, before eggs hatch and leptocephalus larvae migrate back across the Atlantic to begin the continental phase of their life history (Schmidt 1912, Aarestrup *et al*. 2009, Righton *et al*. 2016).

Country Occurrence:

Native, Extant (non-breeding): Albania; Algeria; Austria; Belarus; Belgium; Bosnia and Herzegovina; Bulgaria; Croatia; Cyprus; Czechia; Denmark; Egypt; Estonia; Faroe Islands; Finland; France; Georgia; Germany; Gibraltar; Greece; Guernsey; Hungary; Iceland; Ireland; Isle of Man; Israel; Italy; Jersey; Latvia; Lebanon; Libya; Lithuania; Luxembourg; Malta; Mauritania; Moldova; Monaco; Montenegro; Morocco; Netherlands; North Macedonia; Norway; Poland; Portugal; Romania; Russian Federation; Serbia; Slovakia; Slovenia; Spain; Sweden; Switzerland; Syrian Arab Republic; Tunisia; Turkey; Ukraine; United Kingdom

FAO Marine Fishing Areas:

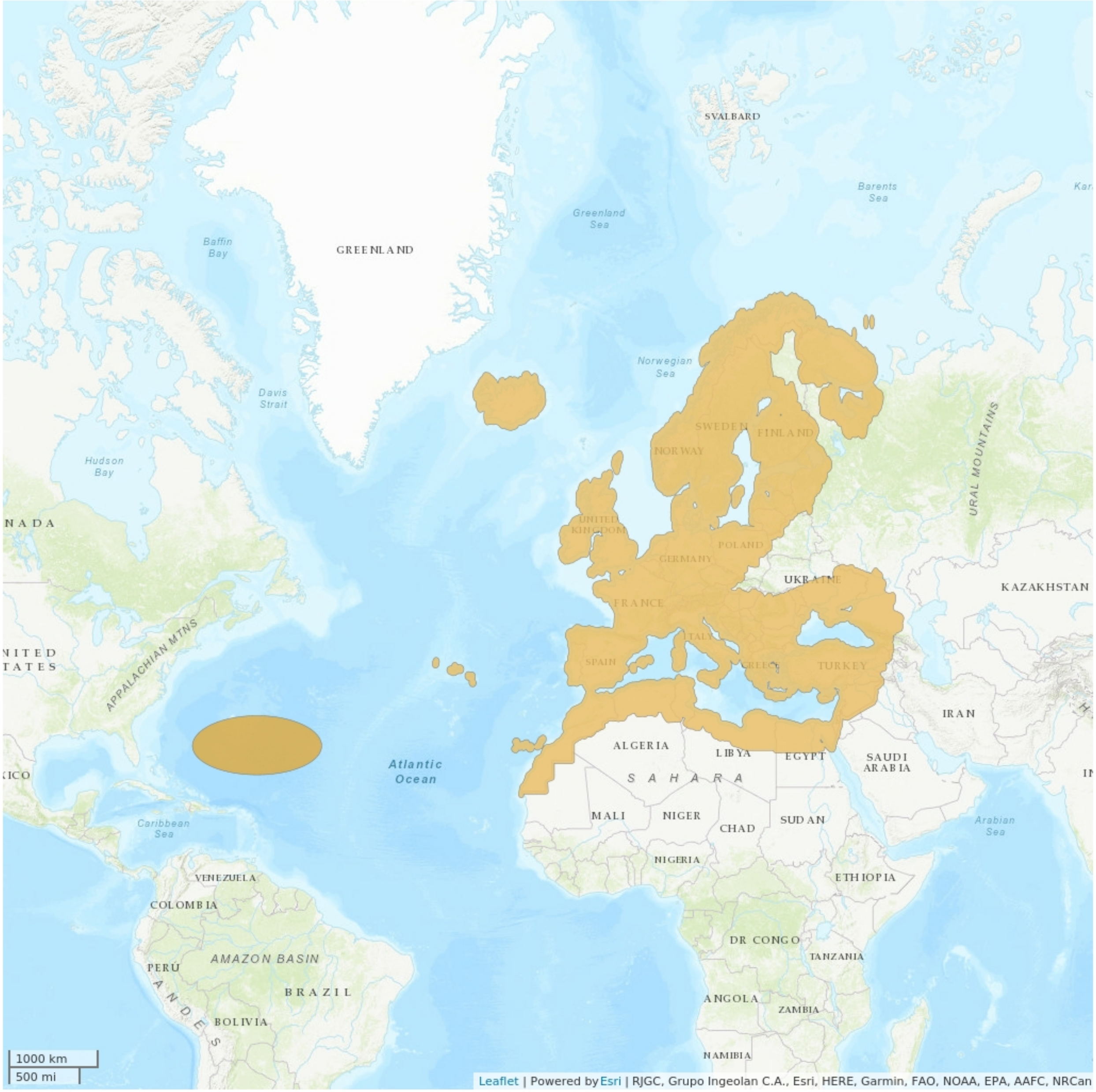
Native: Mediterranean and Black Sea

Native: Atlantic - eastern central

Native: Atlantic - northeast

Native: Atlantic - western central

Distribution Map



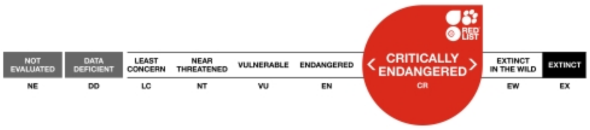
Legend

🟧 EXTANT (BREEDING)

🟧 EXTANT (NON-BREEDING)

Compiled by:

Anguilld Eel Specialist Group (AESG) 2020



The boundaries and names shown and the designations used on this map do not imply any official endorsement, acceptance or opinion by IUCN.

Population

Determining changes in the stock of European Eel is difficult due to limited data and the poor understanding of the relationship between recruitment, eels in continental waters, and escapement. Not only can there be a large time lag (10's of years) between the recruitment of glass eels to fresh and brackish water and the subsequent escapement of silver eels, but given that *Anguilla anguilla* is panmictic, escapement from one area does not translate directly into returning larval recruitment at the same locality. Indeed, for all intents and purposes it is assumed that practically nothing is known about the population dynamics of the oceanic phase of *A. anguilla* (ICES 2013*a*).

Assessment of datasets using the IUCN Red List Categories and Criteria took into account the following: consistency of sampling; longevity of the data set; whether data were eel-specific or multi-species; whether the collection methods were active or passive; whether the watershed the data related to was subject to restocking activity; and/or whether, in the case of fisheries independent data, there was exploitation in the region.

There are more available datasets for *A. anguilla* in northern, central and southern European countries compared to North Africa. For the purposes of analysing recruitment trends, ICES often refers to the North Sea subpopulation in separate terms to the rest of Europe. This is because the rate of decline in abundance of *A. anguilla* recruitment has been shown to be substantially greater for this area compared to elsewhere (ICES 2012), although this declining trend can be mostly accounted for during the period between 1980 and 1985. Declines in both the North Sea and elsewhere indices are presented and considered. Unless otherwise stated, data were accessed through relevant contacts in the EIFAAC/ICES/GFCM Working Group on Eels (WGEEL).

Glass and Yellow Eel Recruitment:

Glass eel and young-of-year recruitment data used to inform this assessment were taken from the analysis provided in ICES (2019*a*). Data used in the ICES recruitment index were from Norway, Sweden, Germany, Denmark, the Netherlands, and Belgium in the "North Sea" series, and UK, Ireland, France, Spain, Portugal, and Italy in the "Elsewhere" series (ICES 2019*a*). Yellow eel recruitment is based largely on data from the Baltic area where only yellow stage eels are recruited (ICES 2019*a*).

Since the early 1980s, a steady and almost continent-wide decline has been observed in the recruitment of glass eels. The ICES recruitment index fell to its lowest historical level in 2012: less than 1% for the North Sea and 5% elsewhere in the distribution area with respect to recruitment from between 1960–1979 (ICES 2012). In the most recent ICES report, the provisional 2019 recruitment index was at 1.4% of the 1960–1979 reference level in the 'North Sea' series, and at 6.0% in the 'Elsewhere' series (ICES 2019*a*). These provisional values for 2019 show a slight decrease from final 2018 values, which were 1.9% in the 'North Sea' index, and 8.9% in the 'Elsewhere' index (ICES 2019*a*). However, statistical analyses conducted on recruitment data have shown the trend from 2011–2019 has increased significantly from zero (ICES 2019*a*). Yellow eel recruitment to European waters was 26.4% of the 1960–1979 reference in 2018 (ICES 2019*a*). Data collection for 2019 was stated to be ongoing and so not available at the time of publication (ICES 2019*a*). The overall decline in recruitment will likely continue to influence adult stock for at least one generation length (ICES 2012).

Yellow Eel (standing stock):

There were few time-series data sets available to this assessment for the yellow eel life stage, and they only cover a small amount of the geographical range. Data sets were made available from Skagerrak (southern Norway), Den Burg (Netherlands) and the East Anglian River Basin District (RBD) in the UK (Rivers Blackwater, Colne, Chelmer, Stour) (Environment Agency 2019). Skagerrak and Den Burg data derive from beach seines and fyke nets, respectively, and the East Anglian RBD data derive from electrofishing surveys. Data from Skagerrak contained mostly yellow eels, with some silvers, whereas the other data sets were for yellow eel only.

The analyses of yellow eel data suggest declines that were not as severe as that of recruitment: in the East Anglian RBD, the mean decline was between 50% and 80%, recognising the paucity of data, over a period of three generation lengths (39 years); in Skagerrak and Den Burg, the mean decline mirrored this trend. There is a variety of published literature describing abundance trends in yellow eels not captured within this analysis - note the following examples are not comprehensive. In the Bristol Channel, sampling conducted between 1981 and 2009 at power station cooling water intakes found yellow eel abundance to decline by 15% per year, to 1% of the level in 1980 (Henderson *et al*. 2012). Similarly, abundance decline has been documented in the River Meuse, in Belgium (Matondo and Ovidio 2016), and Ireland, in both the Foyle Estuary (Barry *et al*. 2015) and Lough Sheelin, in the upper River Shannon catchment (MacNamara *et al*. 2016). Conversely, a study to establish the status of stocks in England and Wales found rivers along the West coast, and some in the northeast remained similar, whereas declines were observed in the south-east (Bark *et al*. 2007). Fisheries-independent monitoring conducted on six sites along the Swedish west coast found yellow eel CPUE to display a slow increase between 1975 and 2003, after which it decreased, before increasing again from around 2011 (Andersson *et al*. 2019).

Declines in yellow eels were identified earlier than that of glass eel recruitment, occurring since the 1960’s (Dekker and Beaulaton 2016). The less pronounced decline in the yellow eel data analysed here compared to those reported for glass eel indices could be partially due to density-dependent mortality confounding the effects of changes in recruitment (Svedäng 1999). However, it needs to be taken into account that the age range of yellow eels is broad and that there may very well be a time lag in knock-on effects. As such, any increase in recruitment would not be expected to be immediately mirrored in a rise in yellow eel numbers, indeed, it is possible that this life stage may continue to decline.

Silver Eels:

For silver eels, there is similar uneven geographical spread of data. Data sets of silver eel escapement were available from France (MNHN-Dinard and UMS PatriNat unpub. data.), Norway and Ireland and were collected from scientific surveys. Note that the silver eel escapement estimates generated for EMPs are only available from 2010 and therefore not dating back long enough to be used in these analyses.

Based on these data, silver eel decline does not appear as pronounced as for recruitment indices but, similar to yellow eels (standing stock), they indicated a mean decline of between 50% and 80%, recognising the paucity of data, over the period of three generation lengths (39 years). Again, the less pronounced decline compared to recruitment indices may be due to density-dependent mortality at previous life stages, but it cannot be ruled out that a decline in silver eel escapement may continue despite increases in recruitment and/or yellow eels due to the long generation time.

Note: The 2019 ICES data call included a request for available data on abundance trends for the standing stock of yellow and silver eels (ICES 2019*a*). Information collected for yellow eels included long-term monitoring across various habitats for 70 sites, and for silver eels across 28 sites (ICES 2019*a*). These data have not been reported by ICES yet, but future analysis will provide a more accurate understanding of the situation.

Anguilla anguilla has been included in a number of regional and national Red List assessments in Europe over the past 10 years. The European Eel has been assessed as Critically Endangered across Europe (Freyhof and Brooks 2011), for the Baltic Sea area (HELCOM 2007), as well as in Sweden (Gärdenfors 2010), Denmark (NERI 2009), France (UICN Comité français, MNHN, SFI and AFB 2019), Ireland (King *et al*. 2011) and north Belgium (Verreycken *et al*. 2013). Indeed, the European Eel showed the largest negative trend of any of the freshwater fishes (-75%) in the Belgian report (Verreycken *et al*. 2013). In Norway the status is now Vulnerable (Henriksen and Hilmo 2015).

For the North African range there is considerably less information. A regional Red List assessment in North Africa suggests that *A. anguilla* is Endangered due to a decline in recruitment of 50% in the last 10 years with annual catches declining by between 10 and 25% since the 1980s, and by more in Tunisia alone (Azeroual 2010).

Currently, the best estimate metric for translation into the IUCN criteria for ‘Mature Individuals’ is the silver eel life stage, although this has its limitations. Following escapement from continental waters, there is the possibility that a proportion of silver eels may succumb to the effects of sub-lethal impacts incurred during growth / escapement and/or be predated before reaching the breeding area to spawn.

An alternative metric that could be used in place of silver eel escapement is numbers of leptocephali collected close to the breeding area, as this would also give an indication of the state of the spawning stock. In 2011, sampling across the breeding area for *A. anguilla, A. rostrata* and other non-anguillid species was conducted, following the same methods as previous sampling in this area that occurred in 1983 and 1985, just after the beginning of the decline in eels occurred in 1980 (Hanel *et al*. 2014). Results from this study were compared with the previous sampling, and significantly lower numbers of European Eel leptocephali were collected in 2011, with a reduction in catch rate of 89% and 64% compared to sampling in 1983 and 1985, respectively (Hanel *et al*. 2014). This observation depicts a decrease in the abundance of leptocephali occurring in the Sargasso breeding area over this time period, suggesting a reduction in the spawning stock, and correlating with the reduction in recruitment to continental waters. This is of great concern for the future resilience of the population.

Current Population Trend: Decreasing

Habitat and Ecology (see Appendix for additional information)

There are a number of phases in an eel’s life that have specific terminology; the leaf-shaped marine larval stage is referred to as leptocephalus; these become glass eels as they reach continental waters, before developing into pigmented elvers and then the growth phase: the yellow eel. The final stage is the marine-migratory silver eel which is characterised by silvery counter-shading and large eyes.

Habitat:

The species is found in a range of habitats from small streams to large rivers and lakes, and in estuaries, lagoons and coastal waters (ICES 2015). It also occupies open ocean areas during migrations but is rarely observed in this habitat. Under natural conditions, it only occurs in water bodies that are connected to the sea; it is stocked elsewhere.

Ecology:

The species is facultatively catadromous, living in fresh, brackish and coastal waters but migrating to pelagic marine waters to breed (Tsukamoto *et al.* 1998, Tzeng *et al*. 2000). While there is some understanding of the eel's continental life history, relatively little is known about its marine phase. The migrations in the European Eel's life cycle are the longest and most oceanographically complex of the Anguillid species (Tsukamoto *et al*. 2002).

There are no exact data about specific spawning sites, however, it is hypothesised that spawning takes place in an elliptic zone, about 2,000 km wide in the Sargasso Sea, in the West Central Atlantic (from 70° W and eastward to 50° W) (Miller *et al*. 2019). *Anguilla anguilla* are thought to spawn in the Sargasso Sea in the West Central Atlantic between late winter and early spring (Schmidt 1912, Aarestrup *et al*. 2009, Righton *et al*. 2016). The adults are assumed to die after spawning (Tesch 2003). Oceanic migration of leptocephali is estimated to take about two years on average before they arrive at the continental shelf (Bonhommeau *et al.* 2008, Zenimoto *et al*. 2011). The mechanisms by which leptocephali reach the European and N. African coasts are not well understood. In the Atlantic region, recruitment has been found to follow a South to North gradient over a period of around four to five months (ICES 2020). This starts in September in the North-West and occurs progressively later in the Channel and North Sea (ICES 2020). Recruitment to the Mediterranean is slightly more complex, publications suggest most eel ascent occurs between December and March, and landings suggest a peak in January. Although in some areas, recruitment occur over a wider period, even year-round (ICES 2020).

Glass eels enter freshwater as sexually undifferentiated individuals. Development and differentiation of the sexual organs are thought to be closely correlated with body size and associated with the yellowing phase of the life history. Sex determination is principally driven by environmental factors with density-dependence producing more males at high densities (Davey and Jellyman 2005). Male European eels initially grow faster than females, however, females achieve a greater age and size than males when sexually mature. Furthermore, the mean length increases significantly with latitude in females but not males, whereas age increases significantly in both (Durif *et al*. 2009, M. Aprahamian unpub. data). Male fitness is maximised by maturing at the smallest size that allows a successful spawning migration (a time minimising strategy) such that males tend to emigrate at a length of <450 mm (Davey and Jellyman 2005). Conversely, females adopt a more flexible size-maximising strategy prior to migration that trades off pre-reproductive mortality against fecundity (Davey and Jellyman 2005). There is considerable geographic variation in mean length at metamorphosis of male and female European eels (Vøllestad 1992). Dekker *et al*. (1998) described the extreme sizes in each of the life stages of the European eel from data at a long-term capture locality in the Netherlands, this paper also discussed the international situation, finding no more extreme values (sizes (cm): Min–Max, glass eels: 5.4–9.2, yellow: 6.9–133.0, silver (Male): 21.2–44.4, Silver (Female): 26.4–101.0). Driven by density-dependence, there are often skewed sex ratios at individual localities as well as geographic bias associated with latitude.

Eel growth increases with temperature, as documented in aquaculture (Sadler 1979, Dosoretz and Degani 1987, Holmgren 1996, Ciccotti and Fontenelle 2001), and growth rate is generally faster in saline water than fresh (Acou *et al*. 2003, Daverat and Tomas 2006, Cairns *et al*. 2009). Furthermore, those individuals produced in saline waters usually have significantly higher fat content and contain lower loads of the swim bladder parasite, *Anguillicola crassus* and thus may have improved chances of reaching their spawning grounds (ICES 2009, Marohn *et al*. 2013). Body burden of toxic compounds, that are thought to affect migration and reproductive success, are also variable over regions and river basins, dependent on local pollution pressure (Belpaire *et al*. 2016). During the growth phase, dependent on size, eels feed on a variety of organisms including fish, amphipods and decapod crustaceans. In saline muddy-bottomed habitats, eels forage on bivalves, shrimp, small fish and polychaete worms. The tendency towards piscivory has been linked to eel length: there is evidence that eels >40 cm have the ability to consume larger prey such as fish or crustaceans (Moriarty 1974, Mann and Blackburn 1991, Yalçın-Özdilek and Solak 2007). Lammens *et al*. (1985) observed periods of low chironomid biomass to be a factor resulting in eels switching to prey on fish. In a comparison of two lakes in Germany, piscivory in eels was also concluded to be controlled by macrozoobenthos density (Dörner *et al*. 2009).

The age at which eels undergo the transformation to the silver stage and undertake their spawning migration, is hugely variable and dependent on latitude and temperature of the environment in which they have grown, food availability, physical barriers that block migration routes, growth rate and sex differences. Estimates for average ranges of the continental growth phase were suggested as approximately 2–15 years for males and 4–20 years for females (Tesch 2003) – noting that much older individual eels occur especially in the latter. Durif *et al* (2009) examined a number of data sets from across the species range in relation to age at silvering which indicated a range of 2 to 15 years for males and 2 to 30 years for females. From these ranges, an estimated generation length of 13 years was used for this assessment, inclusive of a two-year larval migration and one-year spawning migration of silver eels (Bonhommeau *et al.* 2008, Zenimoto *et al*. 2011, Righton *et al*. 2016). It has however been stated that there is variability in the accuracy of the methods used to age eels (ICES 2015). Assessment of available data on generation length during the IUCN Red List process highlighted that defining the required single generation length value for species with a broad range of ages-at-maturation such as eels was extremely difficult. Factors that can significantly affect this parameter include longitude and latitude, sex, growth rates, habitat quality and resource availability.

Systems: Freshwater (=Inland waters), Marine

Use and Trade

The various life stages, ranging from glass to silver, of all anguillid species are harvested and traded on a global scale for farming and consumption, with current demand predominantly driven by East Asian markets, in particular Japan and mainland China. A concerning pattern of exploitation is already apparent – when one *Anguilla* species or population becomes over-exploited, industry moves to the next in order to fulfil demand (Gollock *et al.* 2018).

There is clear evidence for this in the case of *A. anguilla*. Traditionally, European Eel was consumed within its European and North African range states – yellow and silver eels were fished for direct consumption, and glass eels were caught for farming and also for consumption (mainly in Spain). Although still consumed within Europe, in recent decades European Eel became increasingly important in fulfilling demand in East Asia (Ringuet *et al*. 2002, Crook 2010, Shiraishi and Crook 2015).

According to FAO data, total annual global *Anguilla* production (catch and aquaculture) has steadily increased since the 1950s, mainly due to the expansion of farming in East Asia. In 2016, eel farming accounted for 98% of total eel production (over 290,000 tonnes (t)), with mainland China responsible for nearly 86% (FAO 2018). Eel farming is reliant on wild-caught juvenile eels (glass eels/elvers) as "seed" as breeding in captivity is not yet commercially viable. Historically, eel farms used species of local provenance. France, Spain, Portugal and the UK are the principal fishing nations for glass eels, and Italy, Denmark, Germany and the Netherlands the main producers of farmed European Eel for consumption within Europe. However, towards the end of the 1990s, a decline in stocks of Japanese Eels, combined with the apparently cheap and abundant supplies of European Eel glass eels, led to many Asian eel farms in Japan, Korea, Taiwan and mainland China, supplementing farms with the European Eel (Briand *et al*. 2008, Ringuet *et al*. 2002, Shiraishi and Crook 2015).

Concerns over the impact international trade was having on European Eel led to it being listed in Appendix II of CITES in 2007. This listing came into force on 13 March 2009 – since then any international trade in this species needs to be accompanied by a permit. In December 2010, however, the European Union (EU) decided to ban all imports and exports of European Eel to and from the EU, as authorities felt they were unable to determine that trade would not be detrimental to the conservation of the species (a requirement for issuance of permits for CITES Appendix II-listed species). There were a number of exceptions to this ban: trade in "pre-Convention" specimens was permitted until the end of 2015), and internal EU trade is still allowed. Trade from non-EU range States to non-EU countries also still occurs (Musing *et al.* 2018).

Global FAO catch data for European Eel are available for the period of 1950–2017, peaking at nearly 20,000 t in 1968 but declining thereafter and between 2013 and 2017, annual catches averaged just over 3,000 t. Over 60% of these catches were reported by five EU Member States: Denmark, France, Italy, the Netherlands and Sweden. The principal non-EU range States reporting catches (10% of the total) were Egypt, Norway, Turkey, Tunisia and Morocco (FAO 2019). Fishing of various life stages continues in a number of range States, but in many cases, catch is now being limited by quotas or other measures set as part of National Eel Management Plans, fulfilling requirements outlined in Eel Regulation - see Conservation Measures. Reported annual glass eel landings in the EU have declined since 1980, to 62.2 t in 2018, and 58.6 t in 2019 (provisional) (ICES 2019*a*).

Live eels and meat are traded globally for consumption and to a much smaller extent *Anguilla* skins and leather products are also in international trade. Global Customs trade data for live, fresh, frozen and prepared/preserved eel (non-species-specific) are available for the last 40 years. According to FAO and UN Comtrade, global annual exports of *Anguilla* averaged around 20,000 t in the late 1970s, after which annual exports showed a steady increase to a maximum of over 130,000 t in 2001. Since then annual exports have been declining, to just over 80,000 t in 2008–2011, increasing again slightly to ~90,000 t in 2013–2015. The export value of these commodities has steadily increased over the past 40 years, reaching USD ~1.6 billion in 2012. Over the last decade, of the four commodity types, live and prepared/preserved eel accounted for nearly 80% of total exports by weight; China has been the main eel exporter and Japan the main importer (Gollock *et al.* 2018). As noted above, a high percentage of eel in international trade is derived from eels having been grown in farms, which includes *A. anguilla* (Musing *et al.* 2018).

Due to a lack of species-specific Customs data, the precise quantities of European Eel in trade are still unknown. However, imports reported by East Asian Customs of live juvenile *Anguilla* eels from European Eel range States for farming purposes (defined as “live eel fry” in East Asia) provide a good indication of the amount of European glass eels in trade outside of the EU (both legal and illegal). Between 2003 and 2008, annual live eel fry imports from European eel range States to mainland China, Taiwan, Province of China, Korea, Japan and Hong Kong fluctuated between ~36 and 70 t. In 2009, annual imports dropped to ~9 t and in 2010 they increased again to nearly 28 t. Since 2011, reported annual imports of live eel fry from *A. anguilla* range States remained less than 10 t. France and Spain were the principal source countries among *A. anguilla* range States until 2010 (when commercial *A. anguilla* trade to and from the EU was banned). Imports from non-EU *A. anguilla* range States, especially from Morocco, began in 2009 and gradually increased over the years, despite a ban for export of glass eels being imposed in this range state since 2013 (Musing *et al.* 2018). Due to the reduced availability of European glass eels over the last decade, increasing quantities of glass eels of other *Anguilla* species have also been imported into East Asia to fulfil demand in farms (Gollock *et al.* 2018).

Since 2009, species-specific CITES trade data for European eel have been reported. Between 2009 and 2016, over 1000 t of live *A. anguilla* and another ~1000 t of meat/bodies were reportedly exported from a number of European Eel range States (mainly Morocco and Tunisia). Main destinations were Korea and Hong Kong. In addition, over 50,000 t of meat/bodies were re-exported, mainly from China to Japan (Musing *et al.* 2018).

There are serious concerns over illegal harvesting and trade of *A. anguilla.* In recent years, 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, principally to China, and have seen traders regularly change travelling routes and their *modus operandi* to circumvent controls (Musing *et al.* 2018). In 2015, EUROPOL initiated Operation LAKE, a European initiative aimed at combatting illegal eel trade. Under this umbrella, there have been a number of investigations into eel smuggling in air freight and personal luggage. For example, in 2017, Greek and Spanish authorities dismantled an international criminal network suspected of having smuggled 10 t of eels from the EU to China; raids led to the arrest of 32 individuals and seizure of 2 t of *A. anguilla* worth EUR 2 million (Europol 2017). However, European Eel appears to still be in the supply chain in East Asia – a recent paper indicated it was prevalent in supermarket products in Hong Kong (Richards *et al.* 2020).

While there is demand for the species, pressures from trade, and unknown quantities in illegal trade, continue to be a serious conservation concern for the species.

A detailed recent analysis of trade in *A. anguilla*, including Customs, CITES and seizure data, is provided in Musing *et al.* (2018).

Threats (see Appendix for additional information)

Anguilla anguilla is susceptible to a number of natural and anthropogenic threats. These threats include but are not limited to; barriers to migration, climate change, habitat loss/degradation, invasive species, parasitism, pollution, predation and unsustainable exploitation (Drouineau *et al*. 2018). The occurrence and significance of these threats varies considerably from area to area across the species range. The significance of any single threat, or the synergy it may have with other threats is still poorly understood (Dekker 2004, Jacoby *et al.* 2015, Miller *et al*. 2016). It is therefore important to highlight that management measures focusing on a single threat, in isolation of other identified pressures (listed below), are less likely to have a significant positive effect on the stock than a combined approach.

There is a significant body of information including a great deal of contradiction in peer-reviewed and grey literature, and in expert opinion, relating to these threats. The assessment process and accompanying external review indicated that a comprehensive discussion of these threats and their impacts was significantly beyond the scope of this assessment. Below, all suspected threats are listed (in alphabetical order), with some (but not all) key references and a very brief synopsis of these threats. This is by no means comprehensive and does not attempt to fully dissect the wide range of views and data on these pressures. As such, a robust and comprehensive analysis of the existing data and opinion on factors linked to the decline in abundance of the European Eel would be extremely timely.

Barriers to migration – including damage by hydropower turbines (Winter *et al*. 2006, Acou *et al*. 2008, Azeroual 2010, van der Meer 2012, Clavero and Hermoso 2015, Wright *et al*. 2015, Besson *et al*. 2016, Mota *et al*. 2016, Bernaś *et al*. 2016, Dainys *et al.* 2017, Piper *et al*. 2018, Verhelst *et al*. 2018*a,b,* Hanel *et al.* 2019).

Climate change and/or changes in oceanic currents (including the influence of the North Atlantic Oscillation (NAO)), and climate related hydrological changes (reduced precipitation, drought) (Castonguay *et al*. 1994, Dekker 2004, Kim *et al*. 2004, Minegishi *et al.* 2005, Bonhommeau *et al*. 2008, Miller *et al*. 2009, Durif *et al*. 2011, Kettle *et al*. 2011, Pacariz *et al*. 2014, Miller and Tsukamoto 2016, Politis *et al*. 2017, ICES 2018*c*).

Disease and parasites (particularly *Anguillicola crassus*) (De Charleroy *et al.* 1990, Würtz and Taraschewski 2000, Vettier *et al*. 2003, van Ginneken *et al*. 2004, Gollock *et al*. 2005, Palstra *et al*. 2007, Sjöberg *et al*. 2009, Haenen *et al*. 2012, Becerra-Jurado *et al*. 2014, Kempter *et al*. 2014, Weclawski *et al*. 2014, Wysujack *et al*. 2014, Muñoz *et al*. 2015, Barry *et al*. 2017, Hafir-Mansouri *et al*. 2018).

Legal and illegal exploitation and trade of eels (ICES 2012, 2013, 2018*c*; Crook 2010, 2014; Shiraishi and Crook 2015, Dekker and Beaulaton 2016, Stein *et al*. 2016, Gollock *et al*. 2018, Musing *et al.* 2018, Dekker 2019, Kaifu *et al*. 2019).

Habitat loss (and associated resource decline) (Boëtius and Boëtius 1980, Svedäng and Wickström 1997, van Ginneken and van den Thillart 2000, Feunteun 2002, Kettle *et al*. 2011).

Pollutants (Robinet and Feunteun 2002, Maes *et al.* 2005, Palstra *et al.* 2006, Geeraerts and Belpaire 2010, Sühring *et al*. 2013, 2014, 2015, Kammann *et al.* 2014, Szlinder-Richert *et al*. 2014, Belpaire *et al*. 2015, 2016, 2019, Claveau *et al*. 2015, Fernández-Vega *et al*. 2015, Jürgens *et al*. 2015, Rosabel *et al*.

2015, Rudovica and Bartkevics 2015, Caron *et al*. 2016, Freese *et al*. 2016, 2017, 2019, Maes *et al*. 2008, Michel *et al.* 2016, Polak-Juszczak and Nermer 2016, Castro *et al.* 2018, De Meyer *et al*. 2018, Nowosad *et al*. 2018, Rakocevic *et al*. 2018).

Predation (Carpentier *et al*. 2009, DEFRA 2010, Simpson *et al.* 2015, Wahlberg *et al*. 2014, Wysujack *et al*. 2015, Amilhat *et al*. 2016, Hansson *et al*. 2018, Ovegård 2017, Lennox *et al*. 2018).

Summary:

Barriers to upstream and downstream migration are a threat to the European Eel through reduction of available habitat - pumps or hydropower turbines and their associated screens and water management systems can also cause mortality or sub-lethal injury (ICES, 2019). In the AMBER (Adaptive Management of Barriers in European Rivers) project has begun tracking barriers across Europe, compiling them into a 'Barrier Atlas' to better inform management and conservation (AMBER International 2019). The project is ongoing, but so far around 415,000 barriers - complete or partial, with degree of obstruction not often fully quantified - have been recorded within this tool (AMBER International 2019). Relating in particular to hydropower, 21,387 plants are recorded currently in existence in Europe, with a further 278 under construction, and 8,507 planned (Schwarz *et al*. 2019). In the Iberian Peninsula, 80% of eel habitat had been lost when compared to a 19th century baseline, as a result of dams causing fragmentation (Clavero and Hermoso 2015). A full life cycle model developed by Bevacqua *et al*. (2015) suggested the decline of the European Eel between 1975 and 1985 may be somewhat attributed to habitat loss. The model projected a reduction in suitable eel habitat, by 16% in the Mediterranean and 71% in the North and Baltic seas (Bevacqua *et al*. 2015). Degradation and loss of available habitat is also exacerbated by development, flood control, water-level management and the abstraction of surface and ground water for both domestic and commercial use (Drouineau *et al*. 2018). For example, Portugal, Spain and Morocco have been impacted by dam construction and/or drought in recent decades (Kettle *et al.* 2011). Further, it has been hypothesised, that the decline in good quality habitat and associated resources may be causing a decline in body condition of escaping silver eels in parts of the range which may have effects on the success of migration and/or spawning due this species', particularly the female's, reliance on fat stores for reproductive success (van Ginneken and van den Thillart 2000).

Climate change has been proposed to play a role in fluctuations of abundance in *A. anguilla* – particularly larval transport and glass eel recruitment - through its impact on the suspected breeding area (Sargasso Sea) and on changing oceanic conditions that can influence the recruitment of glass eels to near shore and freshwater environments. An important consideration in this discussion is the time scale over which changes are thought to occur as a result of oceanic conditions. The North Atlantic Oscillation (NAO) and the associated climate variability that this brings to the North Atlantic have been dated as far back as the Holocene (Kim *et al*. 2004). As such, fluctuations in climate do occur naturally and have been influencing eel populations for millions of years (Minegishi *et al*. 2005).

The NAO has been studied as a driver of recruitment in both the European and American Eel, with published literature arguing for and against this hypothesis. Durif *et al*. (2011) indicated that periods of high NAO appear to negatively correlate with recruitment to freshwater habitats due to larval metamorphosis being impeded due to the larvae being driven into colder water, slowing the process considerably. Further, changing ocean climate might potentially be responsible for fluctuations in productivity and thus food availability for leptocephali (Miller *et al*. 2009, Miller and Tsukamoto 2016).

Using a high-resolution ocean model, Baltazar-Soares *et al*. (2014) found ocean current variations to be a major driver in the onset of decline in European Eel recruitment that occurred in the early 1980s. Although after this period, the correlation between oceanic fluctuations and eel recruitment was lost, and lack of recovery was likely a result of other pressures (Baltazar-Soares *et al*. 2014). Pacariz *et al*. (2014), however, found that the overall success of larval drift from the spawning ground to the East Atlantic was not affected by changes in climate between 1958–2008, suggesting that trends in recruitment are attributable to factors other than changing currents, a theory also supported by Henderson *et al*. (2012). Politis *et al*. (2017) found 18°C to be optimum temperature for spawning of *A. anguilla* under experimental conditions. The results suggested *A. anguilla* may inhabit a deeper layer of the Sargasso Sea during early life stages and may be vulnerable to changes in temperature as a result of ocean warming. A recent ICES WGEEL report described climate change and increasing ocean temperature under "new and emerging threats", due to unusually warm and dry periods occurring throughout European countries (ICES 2018*c*). This warm and dry period resulted in higher water temperatures, reduced levels of dissolved oxygen, and in some cases habitat loss through drought, creating stressful conditions for eels and other freshwater biota (ICES 2018*c*). There were several reports of eel mortalities from European countries, connected to warmer water, increased instances of disease, or deaths that could not be explained (ICES2018*c*).

The parasite nematode (*Anguillicola crassus*), introduced when the Japanese Eel (*A. japonica*) was imported to Europe for culture in the early 1980s, is also thought to impact the ability of the European Eel to reach its spawning ground. There multiple proposed impacts which include a negative effect on silver stage physiology (Fazio *et al*. 2012); swimbladder damage which impairs swimming performance (Palstra *et al*. 2007); and a reduced ability to cope with high pressure during their reproductive migration (Vettier *et al*. 2003, Sjöberg *et al*. 2009). Prevalence of *A. crassus* has been found to be higher in smaller eels (Barry *et al*. 2017, Hafir-Mansouri *et al*. 2018), with the proposal that smaller eels feeding mainly on invertebrates have a greater infection intensity than larger, piscivorous eels, because of increased chance of encounter with infected invertebrate hosts (Barry *et al*. 2017).

Lipophilic pollutant contaminants and metals act as stressors within the continental stage of the European Eel life cycle (Drouineau *et al*. 2018, Belpaire *et al.* 2019). This can result in damage to the respiratory system, tissues and organs, alter the regular function of endocrine processes, osmoregulation, and haematological dynamics, as well as decreasing protein content, reducing the ability of an eel to cope with physiological stress (Geeraerts and Belpaire 2010, Belpaire *et al*. 2016, 2019, De Meyer *et al*. 2018). Lipids are essential for allowing normal migration and reproduction (Belpaire *et al.* 2019). As pollutants impair lipid metabolism and storage, it may reduce the ability of silver eels to migration (Belpaire *et al.* 2019). Chemicals stored by eels and released when fat stores are broken down during migration, could subsequently limit the capacity of the silver eels to complete their spawning migrations due to metabolic disruption (Robinet and Feunteun 2002, Palstra *et al.* 2006, Drouineau *et al*. 2018, Belpaire *et al*. 2019). Further, there is concern that even if the spawning migration is completed that lipid stores containing xenobiotics may result in disrupted gonadogenesis and/or low-quality gametes, as well as transmission of pollutants to the larvae (Robinet and Feunteun 2002, Sühring *et al*. 2015, Belpaire *et al*. 2016;,Freese *et al.* 2017, 2019, Drouineau *et al*. 2018, Nowosad *et al*. 2018). Ultimately, pollutants may be affecting eels at molecular and individual levels, but also scaling to population and community wide effects (Belpaire *et al*. 2016, 2019). Lipophilic chemical pollutants have been identified as a cause of recruitment failure, although current policies focusing on increasing escapement from continental waters do not consider eel quality (Belpaire *et al*. 2019). To mitigate impacts of contaminants, it may be valuable for management to integrate methods to improve the condition and quality of both habitats and escaping eels (Freese *et al*. 2016, Belpaire *et al*. 2019). This may also be considered in relation to stocking activities, by ensuring eels have suitable, unpolluted rearing habitat (Freese *et al*. 2016, Belpaire *et al*. 2019).

Predation also represents a threat to *A. anguilla* and is increasingly being discussed in relation to competition with commercial and recreational fisheries. Cormorants in particular have been a focus of recent research, which has found eel consumption by cormorants to be of a similar quantity to that of fishery landings in both the Baltic Sea (Hansson *et al*. 2018) and some lakes in Sweden (Ovegård 2017). Human factors may exacerbate the threat. Under experimental conditions, acoustic disturbance has been found to reduce anti-predation behaviour in eels, affecting likelihood of survival (Simpson *et al*. 2015).

Unsustainable exploitation is a threat to the species. Fishing for the European Eel began with small scale fisheries up to the late 1800s, before shifting during the mid-1900s to larger scale, commercial exploitation, with production peaking between 1960–70 (Dekker and Beaulaton 2016, Dekker 2019, Kaifu *et al*. 2019). Across its distribution, all continental stages of the European Eel are currently exploited although data from different regions varies in quality and period of collection. Trade of European Eel continues within the European Union (EU) for consumption, culture and stocking, although export from the EU has been banned since 2010 although over this time period commercial landings of yellow and silver eels have remained relatively consistent (around 2000–3000 tonnes) (ICES 2019*a*) (see Conservation). Indeed, it seems that yellow/silver eels are declining while glass eel catches increase (European Commission 2020*a*).

Despite the ban on trade outside of the EU, under-reporting, illegal fishing (poaching) and illegal trade are believed to occur throughout the range of the European Eel fisheries (Musing *et al*. 2018). There is little information regarding illegal exploitation of the European Eel, which is thought to be driven mainly by demand from East Asia for use as a substitute for *Anguilla japonica*, due to the reduced abundance of glass eels of this species (Kaifu *et al*. 2019). Assessment of the impact of this component of fishery exploitation is therefore extremely difficult. Export of European Eel outside of EU borders is visible through trade statistics, and enforcement agencies report the tonnage of successful operations where shipments have been intercepted, and seizures made (Musing *et al*. 2018, Kaifu *et al*. 2019). A review of exploitation, including an attempt to understand the scale of eel trafficking for the European Eel was conducted by Stein and Dekker in Kaifu *et al*. (2019).

Conservation Actions **(see Appendix for additional information)**

The majority of conservation actions historically in place for the European eel were set up and controlled at local and national level, often with little coordination, which is of particular concern when dealing with a panmictic stock. Protection can be achieved effectively at a national or local level, distributed throughout individual management units, but an international objective is necessary to orchestrate this management (Dekker 2016).

The Eel Regulation (EC Regulation 1100/2007; EU 2007) is an EU-wide recovery plan for the European Eel, adopted in 2007. As instructed by the regulation, EU member states have been developing and implementing Eel Management Plans (EMPs) with the objective to “reduce anthropogenic mortalities so as to permit with high probability the escapement to the sea of at least 40% of the silver eel biomass relative to the best estimate of escapement that would have existed if no anthropogenic influences had impacted the stock.” (EU 2007). Member States are responsible for implementing measures to achieve their targets, and most actions have focussed on commercial and recreational fisheries, followed by hydropower-pumping station obstacles, and measures on habitat, restocking, and predator control (ICES 2013*b*, European Commission 2020*a*). Other actions expected to have indirect effects, such as implementing monitoring programmes and scientific studies, have been almost as common as controls on fisheries (ICES 2013*b*).

In a review of EMPs, eel biomass per hectare fell within a narrow range for most countries, apart from France and Spain, whose values were higher than what was reported for other countries (ICES 2018*d*). The most recent reporting (2018) did not provide mortality rate estimates for all EMPs, and therefore rates could not be summed to reflect the state of impacts across Europe (ICES 2018*d*). In December 2017, EU Member States reached an agreement prohibiting fishing for eels >12 cm in marine waters of the Atlantic and North Sea over a three-month period (determined by each Member State) between 2018 and 2019 to aid eel recovery (Council of the EU 2018). In 2019, in line with measures implemented by the General Fisheries Commission for the Mediterranean (GFCM), this decision extended the mandatory closures to recreational and glass eel fisheries covering brackish waters (Council of the EU 2019).

As part of the EMPs, any Member State that allowed fishing for eels of <12 cm total was required to reserve a minimum of 60% of their catch from 31 July 2013 onwards for restocking purposes (i.e. restocking waters with glass eels from elsewhere). Although there is evidence showing restocking to be beneficial at enhancing silver eel production within water bodies, the overall effectiveness of restocking programmes at enhancing the spawning stock remains open to debate (ICES 2016). Reviews (ICES 2012, 2016, Pawson 2012) on the contribution of restocking to the recovery of the panmictic European Eel state that there are major knowledge gaps to be filled before firm conclusions can be drawn either way. Until restocking studies are accompanied by suitable controls of areas without translocation, it is very difficult to determine whether there is a net increase in silver eel escapement or differences in growth rates and/or sex ratios in manipulated populations (Pawson 2012).

A recent evaluation of the implementation of the Eel Regulation sought to assess the measures established for the protection and sustainable use of the European Eel stock, as well as the contribution of EMPs to promoting recovery (European Commission 2019, 2020*a*). Overall, escapement of silver eels remains below the 40% target biomass (European Commission 2020*b*). Catches of yellow and silver eel life stages were found to have declined, while glass eel catch has been steadily increasing (European Commission 2020*b*). Overall, there has been progress towards a reduction in fishing effort, but in some Member States’ effort has risen (European Commission 2020*b*). Anthropogenic mortality unrelated to fishing has not significantly declined, and this has received little focus in the EMPs and related actions (European Commission 2020*b*). The report ultimately stated "The Regulation’s success in ensuring the recovery of the European eel is still far from certain, as it is widely recognised that the recovery of the European eel will take many decades. In this respect, further ambition is needed to implement the Regulation with a greater focus on non-fisheries related measures."

Although the Eel Regulation (1100/2007) only applies to EU Member States, efforts are being pursued to non-EU countries to develop and implement management plans and conservation measures. The GFCM are currently in the process of negotiating a regional Eel Management Plan (SAC 2018). The last working group on the management of European eel (WGMEASURES-EEL) occurred on the 16–17th April 2019, where priorities for a regional research programme on eels was discussed, which included drafting an agreed workplan, with a method to launch and implement the programme (SAC 2019). A number of other range states have implemented management measures and/or developed national eel management plans (Musing *et al*. 2018).

In addition to the Eel Regulation, in 2007, the European eel was included in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (CITES 2007). The listing came into effect on 13 March 2009, after which time exporters were required to acquire permits. An export permit may be issued only if the specimen was legally obtained and export is deemed non-detrimental to the survival of the species i.e. a Non-Detriment Finding (NDF). In 2010, the EU's Scientific Review Group (SRG) concluded an NDF was not possible for this species, and so a zero import/export policy was set for the EU, which is still in place (EC 2010, Musing *et al*. 2018). In 2018, several reports investigating the challenges and lessons learnt in relation to implementing the Appendix II listing, including its enforcement and illegal trade were published (CITES 2018, Musing *et al*. 2018).

In 2008, *A. anguilla* was added to the OSPAR List of Threatened and/or Declining Species in the Northeast Atlantic (OSPAR 2010). In 2014, *A. anguilla* was added to Appendix II of the Convention on Migratory Species (CMS) to catalyse collaborative conservation across range States, providing additional support for conservation and monitoring of the species (CMS 2014). Since the listing there have been three range state meetings in order to develop a mechanism under which signatories will work. At the most recent CMS Conference of the Parties in 2020, it was agreed a species Action Plan would be developed for the European Eel.

Across Europe, programmes for "trap and transport" (downriver transport), and "assisted migration" (upriver transport), are in place to provide eels with access to habitat that has been lost through the construction of migratory barriers. When applied to migrating silver eels, it can have a significant and immediate effect on local escapement. It is hoped that translocation can mitigate against the loss of habitat and positively contribute to enhanced escapement, and by association, future recruitment (e.g. for barriers: van der Meer 2012, McCarthy *et al.* 2014, Béguer-Pon *et al*. 2018). There is a necessity in the future, however, to reduce the level of direct human intervention by eliminating the barriers to navigation, or at least, providing more effective passage for eels.

Continuous monitoring of eel escapement on a national or international scale is currently very rare and so in addition to localised monitoring, modelling has been explored for providing estimates of escapement in eel subpopulations. A number of assessment models have been developed; Demographic model of the Camargue (DemCam) (Bevacqua and De Leo 2006), Eel Density Analysis (EDA) (EDA 2.2: Briand *et al*. 2015, EDA 2.2.1: Briand *et al*. 2018), German Eel Model (GEM) (GEM II: Oeberst and Fladung 2012, GEM III: Oeberst and Fladung 2014), and, Scenario-based Model of Eel Production II (SMEP II) (SMEP: developed by El-Hosaini, Bark, Knights, Williams and Kirkwood; Aprahamian *et al*. 2007). Using time series eel data sets from a variety of locations across Europe, earlier iterations of these models were reviewed by Walker *et al.* (2011). The conclusions of this report suggest that all four models were capable of predicting escapement to a degree of accuracy (Walker *et al*. 2011).

In 2019, ICES stated that: “The status of European eel remains critical”, and that “all anthropogenic impacts (e.g. caused by recreational and commercial fishing on all stages, hydropower, pumping stations, and pollution) that decrease production and escapement of silver eels should be reduced to, or kept as close as possible to, zero in 2020” (ICES 2019*b*). In 2019, provisional recruitment estimates remain low across the geographical range. Although, recruitment during the period of 2011–2019 has shown an increasing trend, statistically significant from zero. This highlights the necessity for continued, effective conservation across the range for *A. anguilla*.

Credits

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Disclaimer

External Resources

For Supplementary Material, and for Images and External Links to Additional Information, please see the Red List website.

Appendix

Habitats

(http://www.iucnredlist.org/technical-documents/classification-schemes)

Habitat	Season	Suitability	Major Importance?
5. Wetlands (inland) -> 5.1. Wetlands (inland) - Permanent Rivers/Streams/Creeks (includes waterfalls)	Non-breeding season	Suitable	-
5. Wetlands (inland) -> 5.2. Wetlands (inland) - Seasonal/Intermittent/Irregular Rivers/Streams/Creeks	Non-breeding season	Suitable	-
5. Wetlands (inland) -> 5.3. Wetlands (inland) - Shrub Dominated Wetlands	Non-breeding season	Suitable	-
5. Wetlands (inland) -> 5.4. Wetlands (inland) - Bogs, Marshes, Swamps, Fens, Peatlands	Non-breeding season	Suitable	-
5. Wetlands (inland) -> 5.5. Wetlands (inland) - Permanent Freshwater Lakes (over 8ha)	Non-breeding season	Suitable	-
5. Wetlands (inland) -> 5.6. Wetlands (inland) - Seasonal/Intermittent Freshwater Lakes (over 8ha)	Non-breeding season	Suitable	-
5. Wetlands (inland) -> 5.7. Wetlands (inland) - Permanent Freshwater Marshes/Pools (under 8ha)	Non-breeding season	Suitable	-
5. Wetlands (inland) -> 5.8. Wetlands (inland) - Seasonal/Intermittent Freshwater Marshes/Pools (under 8ha)	Non-breeding season	Suitable	-
5. Wetlands (inland) -> 5.9. Wetlands (inland) - Freshwater Springs and Oases	Non-breeding season	Suitable	-
5. Wetlands (inland) -> 5.11. Wetlands (inland) - Alpine Wetlands (includes temporary waters from snowmelt)	Non-breeding season	Suitable	-
5. Wetlands (inland) -> 5.13. Wetlands (inland) - Permanent Inland Deltas	Non-breeding season	Suitable	-
5. Wetlands (inland) -> 5.14. Wetlands (inland) - Permanent Saline, Brackish or Alkaline Lakes	Non-breeding season	Suitable	-
5. Wetlands (inland) -> 5.15. Wetlands (inland) - Seasonal/Intermittent Saline, Brackish or Alkaline Lakes and Flats	Non-breeding season	Suitable	-
5. Wetlands (inland) -> 5.16. Wetlands (inland) - Permanent Saline, Brackish or Alkaline Marshes/Pools	Non-breeding season	Suitable	-
5. Wetlands (inland) -> 5.17. Wetlands (inland) - Seasonal/Intermittent Saline, Brackish or Alkaline Marshes/Pools	Non-breeding season	Suitable	-

Habitat	**Season**	**Suitability**	**Major Importance?**
5. Wetlands (inland) -> 5.18. Wetlands (inland) - Karst and Other Subterranean Hydrological Systems (inland)	Non-breeding season	Suitable	-
9. Marine Neritic -> 9.1. Marine Neritic - Pelagic	Passage	Suitable	-
9. Marine Neritic -> 9.2. Marine Neritic - Subtidal Rock and Rocky Reefs	Passage	Suitable	-
9. Marine Neritic -> 9.3. Marine Neritic - Subtidal Loose Rock/pebble/gravel	Non-breeding season	Suitable	-
9. Marine Neritic -> 9.4. Marine Neritic - Subtidal Sandy	Non-breeding season	Suitable	-
9. Marine Neritic -> 9.5. Marine Neritic - Subtidal Sandy-Mud	Non-breeding season	Suitable	-
9. Marine Neritic -> 9.6. Marine Neritic - Subtidal Muddy	Non-breeding season	Suitable	-
9. Marine Neritic -> 9.7. Marine Neritic - Macroalgal/Kelp	Non-breeding season	Suitable	-
9. Marine Neritic -> 9.9. Marine Neritic - Seagrass (Submerged)	Non-breeding season	Suitable	-
9. Marine Neritic -> 9.10. Marine Neritic - Estuaries	Non-breeding season	Suitable	-
10. Marine Oceanic -> 10.1. Marine Oceanic - Epipelagic (0-200m)	Breeding season	Suitable	Yes
10. Marine Oceanic -> 10.2. Marine Oceanic - Mesopelagic (200-1000m)	Breeding season	Suitable	Yes
12. Marine Intertidal -> 12.1. Marine Intertidal - Rocky Shoreline	Non-breeding season	Suitable	-
12. Marine Intertidal -> 12.2. Marine Intertidal - Sandy Shoreline and/or Beaches, Sand Bars, Spits, Etc	Non-breeding season	Suitable	-
12. Marine Intertidal -> 12.3. Marine Intertidal - Shingle and/or Pebble Shoreline and/or Beaches	Non-breeding season	Suitable	-
12. Marine Intertidal -> 12.4. Marine Intertidal - Mud Flats and Salt Flats	Non-breeding season	Suitable	-
12. Marine Intertidal -> 12.5. Marine Intertidal - Salt Marshes (Emergent Grasses)	Non-breeding season	Suitable	-
12. Marine Intertidal -> 12.6. Marine Intertidal - Tidepools	Non-breeding season	Suitable	-

Habitat	Season	Suitability	Major Importance?
12. Marine Intertidal -> 12.7. Marine Intertidal - Mangrove Submerged Roots	Non-breeding season	Suitable	-
15. Artificial/Aquatic & Marine -> 15.1. Artificial/Aquatic - Water Storage Areas (over 8ha)	Non-breeding season	Suitable	-
15. Artificial/Aquatic & Marine -> 15.2. Artificial/Aquatic - Ponds (below 8ha)	Non-breeding season	Suitable	-
15. Artificial/Aquatic & Marine -> 15.3. Artificial/Aquatic - Aquaculture Ponds	Non-breeding season	Suitable	-
15. Artificial/Aquatic & Marine -> 15.4. Artificial/Aquatic - Salt Exploitation Sites	Non-breeding season	Suitable	-
15. Artificial/Aquatic & Marine -> 15.5. Artificial/Aquatic - Excavations (open)	Non-breeding season	Suitable	-
15. Artificial/Aquatic & Marine -> 15.6. Artificial/Aquatic - Wastewater Treatment Areas	Non-breeding season	Suitable	-
15. Artificial/Aquatic & Marine -> 15.7. Artificial/Aquatic - Irrigated Land (includes irrigation channels)	Non-breeding season	Suitable	-
15. Artificial/Aquatic & Marine -> 15.8. Artificial/Aquatic - Seasonally Flooded Agricultural Land	Non-breeding season	Suitable	-
15. Artificial/Aquatic & Marine -> 15.9. Artificial/Aquatic - Canals and Drainage Channels, Ditches	Non-breeding season	Suitable	-
15. Artificial/Aquatic & Marine -> 15.10. Artificial/Aquatic - Karst and Other Subterranean Hydrological Systems (human-made)	Non-breeding season	Suitable	-
15. Artificial/Aquatic & Marine -> 15.11. Artificial/Marine - Marine Anthropogenic Structures	Non-breeding season	Suitable	-
15. Artificial/Aquatic & Marine -> 15.13. Artificial/Marine - Mari/Brackishculture Ponds	Non-breeding season	Suitable	-

Use and Trade

(http://www.iucnredlist.org/technical-documents/classification-schemes)

End Use	Local	National	International
Food - human	Yes	No	No
Establishing ex-situ production *	Yes	Yes	Yes
Other (free text)	Yes	Yes	Yes

Threats

(http://www.iucnredlist.org/technical-documents/classification-schemes)

Threat	Timing	Scope	Severity	Impact Score
1. Residential & commercial development -> 1.1. Housing & urban areas	Ongoing	Minority (50%)	Negligible declines	Low impact: 4
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 2. Species Stresses -> 2.2. Species disturbance		
1. Residential & commercial development -> 1.2. Commercial & industrial areas	Ongoing	Minority (50%)	Negligible declines	Low impact: 4
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 2. Species Stresses -> 2.2. Species disturbance		
1. Residential & commercial development -> 1.3. Tourism & recreation areas	Ongoing	Minority (50%)	Negligible declines	Low impact: 4
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 2. Species Stresses -> 2.2. Species disturbance		
2. Agriculture & aquaculture -> 2.1. Annual & perennial non-timber crops -> 2.1.3. Agro-industry farming	Ongoing	Minority (50%)	Causing/could cause fluctuations	Low impact: 5
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.2. Species disturbance		
2. Agriculture & aquaculture -> 2.2. Wood & pulp plantations -> 2.2.2. Agro-industry plantations	Ongoing	Minority (50%)	Causing/could cause fluctuations	Low impact: 5
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.2. Species disturbance		
2. Agriculture & aquaculture -> 2.3. Livestock farming & ranching -> 2.3.3. Agro-industry grazing, ranching or farming	Ongoing	Majority (50-90%)	Slow, significant declines	Medium impact: 6
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.2. Species disturbance		
3. Energy production & mining -> 3.1. Oil & gas drilling	Future	Minority (50%)	Unknown	Unknown
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.2. Species disturbance		
3. Energy production & mining -> 3.3. Renewable energy	Ongoing	Minority (50%)	Slow, significant declines	Low impact: 5
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.1. Species mortality 2. Species Stresses -> 2.2. Species disturbance		

4. Transportation & service corridors -> 4.1. Roads & railroads	Ongoing	Minority (50%)	Causing/could cause fluctuations	Low impact: 5
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.2. Species disturbance		
4. Transportation & service corridors -> 4.2. Utility & service lines	Future	Minority (50%)	Unknown	Unknown
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.2. Species disturbance		
5. Biological resource use -> 5.3. Logging & wood harvesting -> 5.3.4. Unintentional effects: (large scale) [harvest]	Past, unlikely to return	Minority (50%)	Unknown	Past impact
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.2. Species disturbance		
5. Biological resource use -> 5.4. Fishing & harvesting aquatic resources -> 5.4.1. Intentional use: (subsistence/small scale) [harvest]	Ongoing	Majority (50-90%)	Slow, significant declines	Medium impact: 6
	Stresses:	2. Species Stresses -> 2.1. Species mortality		
7. Natural system modifications -> 7.2. Dams & water management/use -> 7.2.1. Abstraction of surface water (domestic use)	Ongoing	Minority (50%)	Causing/could cause fluctuations	Low impact: 5
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.1. Species mortality 2. Species Stresses -> 2.2. Species disturbance		
7. Natural system modifications -> 7.2. Dams & water management/use -> 7.2.2. Abstraction of surface water (commercial use)	Ongoing	Minority (50%)	Causing/could cause fluctuations	Low impact: 5
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.1. Species mortality 2. Species Stresses -> 2.2. Species disturbance		
7. Natural system modifications -> 7.2. Dams & water management/use -> 7.2.3. Abstraction of surface water (agricultural use)	Ongoing	Minority (50%)	Causing/could cause fluctuations	Low impact: 5
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.1. Species mortality 2. Species Stresses -> 2.2. Species disturbance		
7. Natural system modifications -> 7.2. Dams & water management/use -> 7.2.5. Abstraction of ground water (domestic use)	Ongoing	Minority (50%)	Causing/could cause fluctuations	Low impact: 5
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.2. Species disturbance		

7. Natural system modifications -> 7.2. Dams & water management/use -> 7.2.6. Abstraction of ground water (commercial use)	Ongoing	Minority (50%)	Causing/could cause fluctuations	Low impact: 5
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.2. Species disturbance		
7. Natural system modifications -> 7.2. Dams & water management/use -> 7.2.7. Abstraction of ground water (agricultural use)	Ongoing	Minority (50%)	Causing/could cause fluctuations	Low impact: 5
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.2. Species disturbance		
7. Natural system modifications -> 7.2. Dams & water management/use -> 7.2.9. Small dams	Ongoing	Majority (50-90%)	Causing/could cause fluctuations	Medium impact: 6
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.1. Species mortality 2. Species Stresses -> 2.2. Species disturbance		
7. Natural system modifications -> 7.2. Dams & water management/use -> 7.2.10. Large dams	Ongoing	Minority (50%)	Slow, significant declines	Low impact: 5
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.1. Species mortality 2. Species Stresses -> 2.2. Species disturbance		
8. Invasive and other problematic species, genes & diseases -> 8.1. Invasive non-native/alien species/diseases -> 8.1.1. Unspecified species	Ongoing	Majority (50-90%)	Unknown	Unknown
	Stresses:	2. Species Stresses -> 2.1. Species mortality		
8. Invasive and other problematic species, genes & diseases -> 8.1. Invasive non-native/alien species/diseases -> 8.1.2. Named species (Anguillicoloides crassus)	Ongoing	Majority (50-90%)	Unknown	Unknown
	Stresses:	2. Species Stresses -> 2.2. Species disturbance 2. Species Stresses -> 2.3. Indirect species effects		
9. Pollution -> 9.1. Domestic & urban waste water -> 9.1.1. Sewage	Ongoing	Minority (50%)	Unknown	Unknown
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects		
9. Pollution -> 9.1. Domestic & urban waste water -> 9.1.2. Run-off	Ongoing	Minority (50%)	Unknown	Unknown
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects		
9. Pollution -> 9.2. Industrial & military effluents -> 9.2.2. Seepage from mining	Ongoing	Minority (50%)	Unknown	Unknown
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects		
9. Pollution -> 9.3. Agricultural & forestry effluents -> 9.3.3. Herbicides and pesticides	Ongoing	Majority (50-90%)	Causing/could cause fluctuations	Medium impact: 6
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion		

		1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.1. Species mortality		
9. Pollution -> 9.5. Air-borne pollutants -> 9.5.1. Acid rain	Ongoing	-	-	Low impact: 3
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation		
9. Pollution -> 9.6. Excess energy -> 9.6.1. Light pollution	Future	Minority (50%)	Unknown	Unknown
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.2. Species disturbance		
9. Pollution -> 9.6. Excess energy -> 9.6.2. Thermal pollution	Ongoing	Minority (50%)	Unknown	Unknown
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.2. Species disturbance		
11. Climate change & severe weather -> 11.1. Habitat shifting & alteration	Ongoing	-	-	Low impact: 3
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation		
11. Climate change & severe weather -> 11.2. Droughts	Ongoing	Majority (50-90%)	Causing/could cause fluctuations	Medium impact: 6
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.1. Species mortality 2. Species Stresses -> 2.2. Species disturbance		
11. Climate change & severe weather -> 11.4. Storms & flooding	Ongoing	Majority (50-90%)	Unknown	Unknown
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.2. Species disturbance		
11. Climate change & severe weather -> 11.5. Other impacts	Ongoing	Whole (>90%)	Causing/could cause fluctuations	Medium impact: 7
	Stresses:	2. Species Stresses -> 2.1. Species mortality 2. Species Stresses -> 2.2. Species disturbance 2. Species Stresses -> 2.3. Indirect species effects		

Conservation Actions in Place

(http://www.iucnredlist.org/technical-documents/classification-schemes)

Conservation Action in Place
In-place research and monitoring
Action Recovery Plan: Yes
Systematic monitoring scheme: Yes
In-place land/water protection

Conservation Action in Place
Area based regional management plan: Yes
In-place species management
Harvest management plan: Yes
Successfully reintroduced or introduced benignly: Yes
In-place education
Included in international legislation: Yes
Subject to any international management / trade controls: Yes

Conservation Actions Needed

(http://www.iucnredlist.org/technical-documents/classification-schemes)

Conservation Action Needed
2. Land/water management -> 2.1. Site/area management
2. Land/water management -> 2.3. Habitat & natural process restoration
3. Species management -> 3.1. Species management -> 3.1.1. Harvest management
3. Species management -> 3.1. Species management -> 3.1.2. Trade management
5. Law & policy -> 5.1. Legislation -> 5.1.1. International level
5. Law & policy -> 5.1. Legislation -> 5.1.2. National level
5. Law & policy -> 5.4. Compliance and enforcement -> 5.4.1. International level
5. Law & policy -> 5.4. Compliance and enforcement -> 5.4.2. National level

Research Needed

(http://www.iucnredlist.org/technical-documents/classification-schemes)

Research Needed
1. Research -> 1.2. Population size, distribution & trends
1. Research -> 1.3. Life history & ecology
1. Research -> 1.4. Harvest, use & livelihoods
1. Research -> 1.5. Threats
1. Research -> 1.6. Actions
3. Monitoring -> 3.1. Population trends

Additional Data Fields

Population
Continuing decline of mature individuals: Yes
Population severely fragmented: No
Habitats and Ecology
Continuing decline in area, extent and/or quality of habitat: Yes
Generation Length (years): 13
Movement patterns: Full Migrant
Congregatory: Congregatory (and dispersive)

The IUCN Red List Partnership

The IUCN Red List of Threatened Species™ is produced and managed by the IUCN Global Species Programme, the IUCN Species Survival Commission (SSC) and The IUCN Red List Partnership.

The IUCN Red List Partners are: Arizona State University; BirdLife International; Botanic Gardens Conservation International; Conservation International; NatureServe; Royal Botanic Gardens, Kew; Sapienza University of Rome; Texas A&M University; and Zoological Society of London.