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Anguilla anguilla, European Eel

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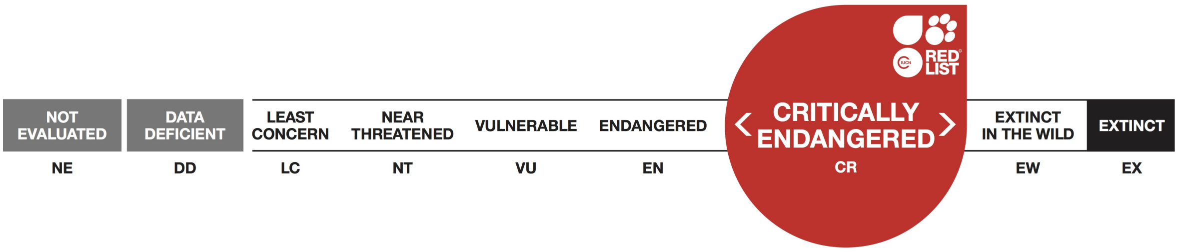

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Taxonomy

Kingdom	Phylum	Class	Order	Family
Animalia	Chordata	Actinopterygii	Anguilliformes	Anguillidae

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

Synonym(s):

- *Muraena anguilla* Linnaeus, 1758

Regional Assessments:

- Northern Africa
- Europe

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, likely due to stocking attempts, but are relatively rare (Böetius 1976). DNA analysis is the best tool to distinguish between European Eels and other species, and *A. rostrata* have fewer vertebrae than *A. anguilla* (102-112, usually 106-108, vs. 111-119, usually 114-116). Hybrids are known to have been found 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: 2014

Date Assessed: May 28, 2013

Justification:

Anguilla anguilla exhibits facultative catadromy, has multiple life stages, and is semelparous and panmictic; these life history traits made application of the IUCN Red List criteria more 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: this element of the population is particularly poorly understood.

Ideally, the IUCN Red List criteria would be applied to mature eels at their spawning grounds, and in the absence of such data, 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 spawning stock biomass, but data sets for this are very rare. The majority of available data relates to glass eels and yellow eels but the relationships between recruitment, yellow eel populations, silver eel escapement, and spawner stock biomass are poorly understood. As such, the IUCN Red List criteria have to be applied to an amalgamation of multiple life stages, which may not exactly mirror the mature spawning stock but can be used as the current best estimate. Finally, the European Eel is a panmictic species, i.e. they come from one spawning stock. Taken literally, this assumes equal importance of the continental populations, and as such escapement from a specific river/country/region is not equivalent to the subsequent recruitment as this relies on the spawning stock as a whole, irrespective of escapement location. However, there are hypotheses that certain regions may have greater importance for the spawning stock, e.g. males primarily escaping from North Africa (Kettle *et al*. 2011), and as data are only available from certain parts of the species' range - data are particularly sparse for Mediterranean and North African populations - it is important that conservation initiatives and management actions are adjusted as new data become available.

In relation to *A. anguilla*, only a very small amount of data are available for silver eels, and while this is not geographically representative of the stock as a whole, a cursory analysis of this alone indicates that the mean decline in silver eel escapement is estimated to be 50-60% over the period of three generations (45 years), just placing them in the Endangered category. There is a similar dearth and uneven geographical spread in the data that relates to yellow eels; however, taking these limitations into account, analysis indicates that there has been a slightly greater decline in this life stage compared to silver eels. Compounding these declines in escapement of maturing eels, according to the available data, there has been substantial declines (90-95%) in recruitment of the European Eel across wide areas of its geographic range during the period of the last 45 years (or three generations) due to a range of threats facing freshwater eels at multiple life history stages. Recruitment has fluctuated during the last century. However, the analysis carried out as part of the IUCN Red List assessment mirrors the WGEEL recruitment index (five year average) which, despite increases in recruitment during the last few years, is currently at its lowest historical level of 1-10% the recruitment of the 1980s, (ICES WGEEL 2013). Further, there is concern that due to the period of time eels spend feeding and growing, prior to silvering and migrating to spawn, that silver eels may continue to decline, even if recruitment is showing recovery.

There is a suite of threats that have been implicated in causing the decline in European Eel recruitment and stocks: barriers to migration – including damage by hydropower turbines; poor body condition; climate change and/or changes in oceanic currents; disease and parasites (particularly *Anguillicola crassus*); exploitation and trade of glass, yellow and silver eels; changing hydrology; habitat loss; pollutants; and predation. The impact of these threats individually or synergistically, are likely regionally specific; however, more broadly, climate and ocean currents have been suggested to play an important role in the survival and transport of the leptocephalus larvae and recruitment of glass eels to coastal, brackish and freshwater habitat. Further research is required to fully understand the complexities of this particular aspect of the eel's life history but there are conflicting opinions as to the degree, if any, which oceanic factors contribute to broad fluctuations in eel numbers.

Eel Management Plans (EMPs) have been developed in European countries since 2007 as a stipulation of the EU Council Regulation No 1100/2007 relating to the recovery of the European Eel. Currently, more than 50% of the 81 EMP progress reports across Europe are failing to meet their target silver eel biomass escapement of 40% in accordance with the regulation, indicating that more work is required

(WKEPEMP 2013). Further, international regulation was enforced for this species in 2007 when CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) listed *A. anguilla* on Appendix II (this came into force in March 2009). Since this time, exports outside of Europe have been banned due to concern 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.

A number of management measures are being implemented in line with EMPs, for example easing of barriers. The influence of these measures, however, will take time to determine as they have only very recently been implemented and very much focus on the freshwater component of the eel's life-history. Arguably the most widely practised measure is restocking; however, there remains a great deal of debate as to whether this benefits eel spawning stocks and thus enhanced future recruitment. Measures that apply to silver eels, such as fisheries management, and/or trap and transport programmes, can theoretically have an almost immediate effect on the potential spawning stock, although when carried out in isolation, their benefit is significantly reduced.

As stated above, the relationship between life-stages is poorly understood, but it was generally agreed that it is very likely that the low recruitment will ultimately translate, though not linearly, to reduced future escapement for, at best, one generation length (15 years). Further, low recruitment has been proposed to be indicative of low historical breeding stock due to the relatively short time period (~2 years) between spawning and subsequent glass eel abundance. As such it was deemed appropriate to assign *A. anguilla* a Critically Endangered listing under current observations and future projected reductions of mature individuals (A2bd+4bd).

While this status is unchanged from the previous assessment, it is important to highlight that the process of this designation was very different in that it was carried out as part of an anguillid specific workshop, and that new data were incorporated – for example the generation length was reduced. There was general agreement that the situation had improved, albeit slightly, for this species both as far as recruitment and implementation of management measures was concerned. As such it is imperative to highlight that this listing is borderline, and that if the recently observed increase in recruitment continues, management actions relating to anthropogenic threats prove effective, and/or there are positive effects of natural influences on the various life stages of this species, a listing of Endangered would be achievable. Further, a drive to fill data gaps – particular in relation to the southern range of this species – would allow an even more robust assessment, and we strongly recommend an update of the status in five years.

Assessment of this species was carried out during a workshop held at the Zoological Society of London from July 1st-5th, 2013.

Previously Published Red List Assessments

2010 – Critically Endangered (CR)

2008 – Critically Endangered (CR)

2006 – Not Evaluated (NE)

Geographic Range

Range Description:

Anguilla anguilla has been shown to be 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). 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 where it migrates east to the Kuban drainage (occasional individuals reach the Volga drainage through canals), in northern Scandinavia and eastern Europe. A report by the ICES Study Group on Anguillid Eels in Saline Waters (SGAESAW) indicates that eel populations typically contain a mix of freshwater residents, saline water residents, and inter-habitat migrants (ICES/SGAESAW 2009). It also widely occurs in most inland waters of Europe (e.g. lakes). It is thought that 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 example, in England and Wales, there are thought to be a total of 2,694 km² of transitional waters, which account for approximately 68% of the potential eel producing habitat across all 11 River Basin Districts (Defra 2010).

For several decades prior to an EU-wide ban on export 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), however these are not thought to contribute to the population 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).

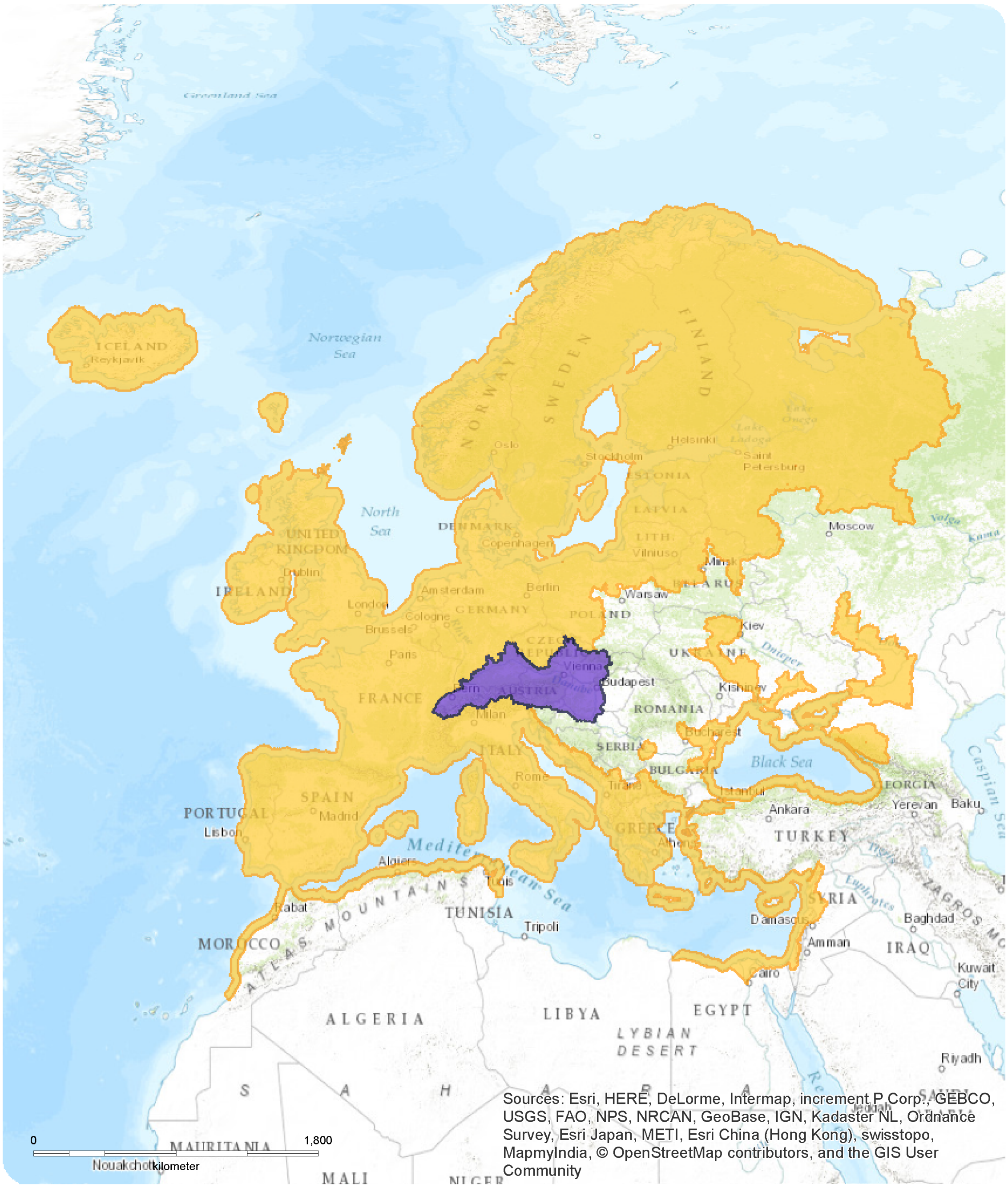
Country Occurrence:

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

FAO Marine Fishing Areas:

Native: Atlantic - eastern central, Atlantic - northeast, Atlantic - western central, Mediterranean and Black Sea -

Distribution Map



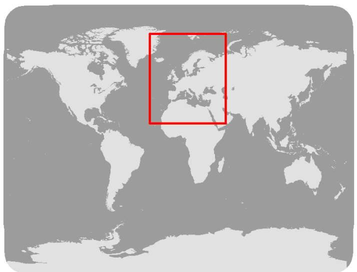
Anguilla anguilla

NE DD LC NT VU EN CR CRITICALLY ENDANGERED EW EX

Range

- Extant (resident)
- Introduced

Compiled by:
Kottelat, M. & Freyhof, J. (2008)



Population

A subset of the recruitment index data in the ICES WGEEL 2012 report was used for analysis i.e., data collected as part of fisheries independent scientific monitoring or fisheries dependent data with an associated metric of effort (e.g. catch per unit effort (CPUE)). Other data were kindly provided by Dr Brian Knights, and this was included as part of the assessment process. Catch effort can be variable in fishing data, and under-reporting and, in some cases, an absence of reporting of landings is a serious problem in most European countries. Thus landings data cannot be accepted as a precise measure of stock status. However, trends in the reported catch data will, to some extent, reflect true changes in fishing yields. All the data were analysed to assess trends in recruitment, population and spawner escapement; however, it was primarily used to guide discussions that resulted in the broad agreement of the Critically Endangered listing by the assessment team, which was in turn supported by the majority of reviewers.

There are more data available for *A. anguilla* in northern, central and southern European countries compared to North Africa, however there is considerably less freshwater habitat available to the European Eel in this part of its range. For analytical purposes the North Sea subpopulation is often referred to in separate terms to the rest of Europe by ICES. This is because the decline in abundance of *A. anguilla* has been shown to be substantially greater for this area compared to anywhere else (ICES WGEEL 2012), although this declining trend can be mostly accounted for during the period between 1980 and 1985.

Determining changes in the international stock in anguillid eels is difficult due to limited data and the poor understanding of the relationship between recruitment, freshwater populations, and escapement. Not only is there a huge time lag between the recruitment of glass eels to fresh and brackish water and the subsequent escapement of silver eels, but given that A. anguilla are 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 dynamics of the oceanic phase of A. anguilla (ICES WGEEL 2013). It has been proposed that due to the relatively short time-span between spawning and recruitment that the latter is a good indicator of the past spawning stock that produced the juvenile cohort; this will depend, to an extent, on the significance of oceanic factors on larval transport.

Assessment of these datasets using the IUCN Red List Categories and Criteria took into account, where this information was available, consistency of sampling; longevity of the data set; whether they 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.

Glass and Yellow Eel Recruitment:

The glass eel data sets used in the analyses for this IUCN Red List assessment were from The Netherlands, Sweden, Ireland, France, and Spain. The elver data sets used were from Norway, Sweden, Ireland and Denmark. These data sets were a mix of fisheries CPUE and scientific surveys and as many were drawn from the WGEEL 2012 report it is unsurprising that they reflect the findings of this document, and they are discussed in this context below.

Since the early 1980s, a steady and almost continent wide decline of ~90% has been observed in the recruitment of glass eels. Recently, the WGEEL recruitment index (five year average) fell to its lowest historical level: less than 1% for the North Sea and 5% elsewhere in the distribution area with respect to recruitment from between 1960–1979 (ICES WGEEL 2012). In the last two years however, the recruitment index has increased to 1.5% of the 1960–1979 reference level in the 'North Sea' series, and to 10% in the 'Elsewhere' series, but both remain far from 'healthy' (ICES WGEEL 2013). This could possibly be in response to the closure of silver eel fisheries across Europe in 2009, although this increase is within the natural variation of historical records (ICES WGEEL 2012). Whilst data from catch returns indicate this increase in recruitment, the impact of the overall decline will likely continue to influence adult stock for at least one generation length (ICES WGEEL 2012). Furthermore, the use of fisheries data makes it difficult to assess the full extent of this recent increase in recruitment due to a lack of effort metrics for some data sets and the introduction of quotas which, once reached and fishing ceases, provide no way of estimating subsequent arrivals to coastal freshwater habitat.

Yellow Eel:
Data sets used to assess yellow eel populations were from Sweden, Norway, Ireland, the UK, the Netherlands and France and were a mix of scientific fishing surveys, electrofishing and fisheries. It was raised that some of the Swedish sites may have exhibited less pronounced declines, and in some cases even increases in population, due to stocking (Wickström 1983, Neuman *et al*. 1990, Andersson *et al*. 2012).

While the decline in yellow eel populations was not as severe as that of recruitment, the available data indicated that it was greater than 50% over three generations (45 years). It is very likely that the less pronounced decline will be partially due to density dependent mortality (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 population 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:
The data sets on silver eel escapement were from France, Norway, Ireland and Sweden and were collected from scientific surveys and fisheries.

Silver eel decline was not as pronounced as yellow eel populations or recruitment but, similar to yellow eels, the indication was that the decline across the range was greater than 50% over three generations. Again, this 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 glass eels and/or yellow eels due to the long generation time.

The EU regulation 1100/2007 – article 2.4 states "The objective of each [EU] Eel Management Plan shall 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". According to the ICES WKEPEMP report, assigned to evaluate the current progress of the Europe-wide EMPs, out of 81 eel management units (EMUs), 17 EMU are reported as achieving their biomass targets, 42 are not and 22 did not report

(WKEPEMP 2013). In southern Norway, sharp declines in abundance have been observed since 2000 after relatively long periods of stability (ICES WGEEL 2012).

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) as well as in Sweden (Gärdenfors 2005), Denmark (NERI 2009), France (UICN 2010) Norway (Kålås *et al*. 2010), and Ireland (King *et al*. 2011) and in regional assessments for the Baltic Sea area (HELCOM 2007) and north Belgium (Verreycken *et al*. 2013). Indeed the European Eel showed the largest negative population trend of any of the freshwater fishes (-75%) in the Belgian report (Verreycken *et al*. 2013).

For the North African range of the population 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).

Current Population Trend: Decreasing

Habitat and Ecology (see Appendix for additional information)

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. 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. 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 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 brackish water, before developing into the pigmented, growth phase: the yellow eel. The final stage is the marine-migratory silver eel which is characterised by silvery counter-shading and large eyes.

There are no exact data about specific spawning sites, however, it is proposed that spawning takes place in an elliptic zone, about 2,000 km wide in the Sargasso Sea, in the West Central Atlantic (about 26°N 60°W). Survey catches of leptocephalus larvae suggest that spawning peaks at the beginning of March continuing through until July (McCleave 1993). The adults are assumed to die after spawning. 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 also not well understood. The main migrations occur in late-autumn to early-spring in Iberian and Bay of Biscay waters, and they are delayed in more northerly sites until temperatures rise in the spring. By the time the leptocephali reach the continental slope they are as large as 100 mm in size and metamorphose into glass eels which are elongate and have a transparent body. These glass eels are observed in the summer and autumn on Portuguese coasts, and in winter and spring in the North Sea.

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 eels 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. 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) produced a paper describing the extreme sizes in each of the life stages of the European Eel from data at a long term capture locality in the Netherlands (Sizes (cm): Min – Max, Glass eels: 5.4 – 9.2, Yellow: 6.9 – 133.0, Silver (M): 21.2 – 44.4, Silver (F): 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 and growth rate is generally faster in saline water than fresh. Furthermore those individuals produced in saline waters usually contain lower loads of the swim bladder parasite, *Anguillicola crassus* and thus may have improved chances of reaching their spawning grounds (ICES/SGAESAW 2009). During maturation, dependent on size, European Eels feed off a variety of organisms including fish, amphipods and decapod crustaceans. In saline muddy-bottomed habitats eels forage on bivalves, shrimp and polychaete worms.

The age at which silver eels mature and undertake their spawning migration is hugely variable and dependent on latitude and temperature of the environment in which they have grown, physical barriers that block migration routes, growth rate and sex differences. From the data available, lower bound estimates for average length of the continental growth phase are approximately 3-8 years for males and 4-5 years for females and upper bound estimates approximately 12-15 years for males and 18-20 for females (Acou *et al*. 2003, Froese and Pauly 2005, Durif *et al*. 2009). Assessment of available data on generation length during the IUCN Red List process highlighted that defining a single figure for species such as eels was extremely difficult. Factors that can significantly affect this parameter include longitude and latitude, sex and habitat quality. Fifteen years was agreed upon after this analysis and it is important to indicate that this is inclusive of an estimated two year larval migration and 0.5 year spawning migration of silver eels.

Systems: Freshwater, Marine

Use and Trade **(see Appendix for additional information)**

The various life stages, ranging from glass eel to silver eel, of all *Anguilla* species are harvested and traded on a global scale for consumption - directly or after culture - and for stocking purposes, 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 declines in abundance or new catch/trade measures come into force limiting exploitation levels, industry moves to the next in order to fulfil demand (Crook and Nakamura 2013).

There is clear evidence for this in the case of European Eel. 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).

Eel farming, which is responsible for over 90% of all *Anguilla* production worldwide (averaging at 280,000 tonnes per year since 2007; FAO 2013), is reliant on wild-caught juvenile eels or glass eels. Raising European eel larvae to the glass eel stage in captivity has never been achieved, and while it has for the Japanese eel, this is not yet commercially viable. Historically, eel farms used species of local provenance. France, Spain, Portugal and the UK were the principal fishing nations for European Eel glass eels, and Italy, Denmark 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, switching to the European eel for their culture material (Ringuet *et al*. 2002).

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). Exceptions to this ban included trade in pre-Convention specimens i.e. those fished prior to the CITES listing coming into force (permitted until April 2012) and internal EU trade. Trade from non-EU range States to non-EU countries is also still permitted (Crook 2011).

Fishing of various life stages continues in a number of European Eel range States, but in most cases catch is being limited by quotas or other measures set as part of National Eel Management Plans (fulfilling requirements outlined in Council Regulation (EC) No.1100/2007 establishing measures for the recovery of the stock of the European Eel (18 September 2007) – see conservation measures).

Anguilla spp. are traded internationally as live eels for farming and consumption, as fresh, frozen and smoked/prepared eels for consumption and as skins and leather products for fashion accessories. Global trade data collated by FAO for live, fresh, frozen and smoked/prepared *Anguilla* species (non-species specific) is available for the period 1976-2009. According to FAO data, global annual Anguilla exports averaged around 20,000 tonnes in the late 1970s (valued annually at 55-95 million US Dollars), after which annual exports showed a steady increase to a maximum of over 130,000 tonnes in 2000 (valued at over 1000 million US Dollars). Since then annual exports have been declining, to just over 80,000 tonnes in 2008 and 2009 (valued at over 800 million US Dollars). By weight, China and Taiwan are responsible for nearly 75% of these exports and Japan for over 75% of all imports (FAO 2013).

Due to a lack of species-specific Customs data, the actual quantities of European Eel in trade is still relatively unknown. However, East Asian Customs imports of live juvenile *Anguilla* eels from European eel range States for farming purposes (defined as “live eel fry” in East Asia) can provide a good indication of the amount of European glass eels in trade (due to their delicate nature and the need for quick transportation to their destination). Between 2003 and 2008, annual live eel fry imports from European eel range States to mainland China, Taiwan, Korea, Japan and Hong Kong fluctuated between ~36 and 70 tonnes. In 2009, annual imports dropped to ~9 tonnes, in 2010 they increased again to nearly 28 tonnes and in 2011 and 2012 were ~7 and ~5 tonnes respectively - these low numbers are a result of the EU ban in place since 2011. Consequently, increasing quantities of glass eels of other Anguilla species are being imported into East Asia to fulfil demand in farms (Crook 2010; Crook and Nakamura 2013, V. Crook/TRAFFIC 2014, in litt/pers. comm.).

Furthermore, since 2009, species-specific CITES trade data for European eel has been reported. Between 2009 -2011, over 360 tonnes of live eels (including 20 tonnes of juvenile eels for farming) were reportedly exported from a number of European Eel range States. Exporters included Algeria, Belgium, Croatia, Denmark, France, Greece, Morocco, Norway, Spain, Switzerland, Tunisia and the UK,and importers included Armenia, mainland China, Denmark, France, Hong Kong, Italy, Macedonia, the Netherlands, Republic of Korea, Russian Federation, Spain, Sweden, Tunisia and Ukraine. During these three years, nearly 30,000 tonnes of *A. anguilla* meat and bodies were also reportedly exported (mostly from farms in mainland China), in addition to ~11,000 leather products and ~13,000 skins (mostly from Mexico, but originating in Korea) (UNEP-WCMC 2013). Since December 2010, illegal trade in European eel has been a concern – authorities have seized several European glass eel shipments destined for East Asian eel farms, in particular coming from Spain and France (TRAFFIC 2012, Crook in litt, 2013).

Note: *double-counting, under-reporting and misreporting must be taken into consideration when interpreting all available catch and trade data. See Crook (2010) for explanations of data issues.*

Threats **(see Appendix for additional information)**

The causes of the declining recruitment rates are still not fully understood (Dekker 2007), and while there are many hypotheses, the significance of any single threat, or the synergy it may have with other threats is still poorly understood. It is important to highlight, however, that management measures focusing on a single threat, in isolation of other identified pressures (listed below), are less likely to have a significant positive effects on eel numbers. 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 – 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. Below we list (in alphabetical order) suspected threats 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 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.

Body condition - Boëtius and Boëtius 1980, Svedäng and Wickström 1997, van Ginneken and van den Thillart 2000.

Climate change and/or changes in oceanic currents (including the influence of the North Atlantic

Oscillation (NAO)) - 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, Pacariz *et al*. 2013.

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.

Exploitation and trade of glass, yellow and silver eels - ICES WGEEL 2012, 2013; Crook 2010; Crook and Nakamura 2013.

Hydrology – e.g. Kettle *et al*. 2011.

Habitat loss – e.g. Feunteun 2002.

Pollutants - Robinet and Feunteun 2002, Maes *et al.* 2005, Palstra *et al.* 2006, Geeraerts and Belpaire 2010.

Predation – e.g. Carpentier *et al*. 2009, DEFRA 2010, Wahlberg *et al*. 2014.

Summary:
One of the major threats to European Eel populations, like many anguillid species, is barriers to upstream and downstream migration, which also includes mortality by hydropower turbines and their associated screens and water management systems. Across Europe, there are a total of 24,350 hydropower plants and this figure is set to rise in the near future (van der Meer 2012). Indeed, in the Netherlands alone there are a total of 4,671 water pumping stations which inhibit the spawning migrations of adult silver eels downstream and the upstream migration of young glass eels. 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 (e.g. agricultural) use. In North Africa, the declines in fisheries catches of all eel life history stages (but glass eel in particular) have been attributed to over-exploitation, dam construction, pollution of estuaries and water abstraction for domestic use (Azeroual 2010). It is proposed 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.

In relation to this, the accumulation of lipophilic chemical pollutants by maturing eels could have potentially toxic effects on migrating adults. These chemicals are stored by the fish and released when fat stores are broken down during migration which 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). 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 (Robinet and Feunteun 2002).

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 grounds (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) during periods of increase and decline.

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 the metamorphosis of larvae into glass eels being impeded by 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). Pacariz *et al*. (2014), however, found that the overall success of drift of larvae 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). As such, the most recent WGEEL report claims that there is still practically nothing known about the dynamics of the oceanic phase of the eels life history (ICES WGEEL 2013).

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 their spawning grounds due to its negative influence on the fitness traits associated with the silvering stage of maturation (Fazio *et al*. 2012) in addition to swimbladder damage which impairs swimming performance (Palstra *et al*. 2007) and the ability to cope with high pressure during their reproductive migration (Vettier *et al*. 2003, Sjöberg *et al*. 2009).

Overfishing of glass - fisheries are primarily in France, with the UK and Spain also contributing -, yellow and silver eels across Europe is also a threat to the species. Across its distribution all continental life history stages of the European Eel are currently exploited although data from different regions varies in quality and longevity. Export outside of Europe is now banned with any trade occurring within Europe (for consumption, culture and stocking) and quotas are in place, however, under-reporting, poaching and illegal trade are believed to occur throughout the range of the European eel fisheries. These activities endanger the species and make assessment of the impact of this fishery difficult, and it's associated management problematic.

Given the relative lack of understanding of the threats we have attempted to quantify this using the IUCN 'Threat Classification Scheme', however, this is by no means definitive.

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 in relation to trans-boundary watersheds.

EMPs have been developed and implemented in EU Member States since the EC Regulation 1100/2007 was created to offer protection, promote recovery and increase of silver eel biomass and enhance the sustainable management of this species. The objective of each EMP is 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. Member States are responsible for implementing measures to achieve their targets, and these measures can include, but are not limited to; reducing commercial and recreational fisheries; restocking; improving habitats and making rivers passable; transportation of silver eels to the sea; reducing predation, amending hydro-electric power turbine schedules to reduce mortality, and developing aquaculture. According to the ICES WKEPEMP report (2013) most management actions have been for commercial and recreational fisheries, followed by hydropower-pumping stations obstacles, then measures on habitat, restocking, and predator control. Other actions expected to have indirect effects, such as implementing monitoring programmes and scientific studies, have been almost as common as controls on fisheries. A total of 756 management actions proposed in the EMPs have been implemented fully, 259 partially and 107 declared as not implemented at all (ICES WKEPEMP 2013).

In addition to EMPs, in 2007, the European eel was included in the CITES Appendix II in order to ensure trade of this commercially important species was sustainable. The listing came into effect on 13 March 2009, after which time all Parties to the Convention were required to issue permits for all exports of the species. An export permit may be issued only if the specimen was legally obtained and if the export is not detrimental to the survival of the species i.e. a Non-Detriment Finding. Finally in relation to international policy, in 2008, *A. anguilla* was added to the OSPAR List of Threatened and/or Declining Species in the Northeast Atlantic (OSPAR 2010).

As part of the EMPs, any Member State that allowed fishing for eels of <12 cm total length – generally referred to as glass eel fisheries - was required to reserve a minimum of 35% of their catch for restocking purposes (i.e. restocking rivers with glass eels from elsewhere) in 2010, rising to 60% from 31 July 2013. Whether restocking programmes actually enhance the population is still open to debate. In recent years, the ICES WGEEL has annually assessed new information on the pros and cons of stocking as a suitable tool for eel recovery, with fuller reviews undertaken in 2006 and 2010 (ICES 2010). Recent reviews (WGEEL 2012, Pawson 2012) on the contribution of stocking for the recovery of the panmictic European eel population unambiguously state that there are major knowledge gaps to be filled before firm conclusions either way can be drawn (ICES WGEEL 2013). To inform this debate, however, researchers are currently seeking to determine whether stocked individuals are able to migrate as successfully and contribute to future generations to the same degree as wild individuals. Long term stocking, marking and monitoring programmes are slowly making progress in this endeavour (Wickström and Sjöberg 2013). A team of researchers in France suggest that the stage at which eels are stocked does not affect their survival (Desprez *et al*. 2013). Tagging and tracking studies, such as those being conducted as part of the EU EELIAD project, are under way in order to gain a better understanding of the marine ecology of the European Eel. Tracking is also adopted to determine the relative success of stocked eels to make spawning migrations and thus contribute to recruitment (e.g. Prigge *et al*. 2013a) and a recent paper indicates that eels from a stocked watershed migrate in a similar way to wild populations in Sweden (Westerberg *et al.* 2013). In summary however, until stocking 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).

Trap and transport programmes across Europe are designed to provide eels with both upstream and downstream passage and/or access to habitat that has been lost through the construction of migratory barriers. These programmes that involve catching wild eels and moving them over relatively small distances past barriers are generally working with lower numbers of fish than restocking programmes and are very location specific. However, when applied to migrating silver eels, low in a catchment, it can have a significant and immediate effect on escapement thus potentially having a positive impact on the spawning stock. It is hoped that translocation can mitigate against the loss of habitat and positively contribute to enhanced escapement, and by association, recruitment. There is a necessity in the future, however, to reduce the level of direct human intervention by providing more cost-effective passes or ladders for eels to navigate.

Continuous monitoring of eel escapement on a national or international scale is currently very rare and highly unlikely and so in addition to localised monitoring, modelling has been explored for providing estimates of escapement in eel subpopulations. The German Eel Model indicated that current levels of silver eel escapement from the Schwentine River system showed 'distinctly lower reference escapement values' than those set by the German EMP (Prigge et al. 2013). Indeed a report for the European Commission by Walker *et al*. (2011) review a number of assessment models (namely the Demographic model of the Camargue (DemCam); Eel Density Analysis 2.0 (EDA); German Eel Model (GEM); and, Scenario-based Model of Eel Production II (SMEP II)) using time series eel data sets from a variety of locations across Europe. 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 summary, the international assessment of the eel stock collated in the 2013 ICES WGEEL report confirms "the critical state of the stock; the promising increase in recruitment observed in the last two years is set in historical perspective; but no prediction can be generated, and no evaluation of the implemented stock protection measures achieved". There is still a critical need for improvement in the quality and consistency of data reporting at the national and Eel Management Unit (EMU) level (ICES WGEEL 2013). Further, it is important to highlight that while conservation actions of varying effectiveness are in place for *Anguilla anguilla* across its range, more is still required, and the apparent rise in recruitment that has occurred in 2011, 2012 and 2013, should not be reason to cease efforts. It was proposed that reassessment of this species will be required in five years, or sooner should considerably more data on silver eel escapement become available in the next few years.

Credits

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External Resources

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	Suitable	-
5. Wetlands (inland) -> 5.2. Wetlands (inland) - Seasonal/Intermittent/Irregular Rivers/Streams/Creeks	Non-breeding	Suitable	-
5. Wetlands (inland) -> 5.3. Wetlands (inland) - Shrub Dominated Wetlands	Non-breeding	Suitable	-
5. Wetlands (inland) -> 5.4. Wetlands (inland) - Bogs, Marshes, Swamps, Fens, Peatlands	Non-breeding	Suitable	-
5. Wetlands (inland) -> 5.5. Wetlands (inland) - Permanent Freshwater Lakes (over 8ha)	Non-breeding	Suitable	-
5. Wetlands (inland) -> 5.6. Wetlands (inland) - Seasonal/Intermittent Freshwater Lakes (over 8ha)	Non-breeding	Suitable	-
5. Wetlands (inland) -> 5.7. Wetlands (inland) - Permanent Freshwater Marshes/Pools (under 8ha)	Non-breeding	Suitable	-
5. Wetlands (inland) -> 5.8. Wetlands (inland) - Seasonal/Intermittent Freshwater Marshes/Pools (under 8ha)	Non-breeding	Suitable	-
5. Wetlands (inland) -> 5.9. Wetlands (inland) - Freshwater Springs and Oases	Non-breeding	Suitable	-
5. Wetlands (inland) -> 5.11. Wetlands (inland) - Alpine Wetlands (includes temporary waters from snowmelt)	Non-breeding	Suitable	-
5. Wetlands (inland) -> 5.13. Wetlands (inland) - Permanent Inland Deltas	Non-breeding	Suitable	-
5. Wetlands (inland) -> 5.14. Wetlands (inland) - Permanent Saline, Brackish or Alkaline Lakes	Non-breeding	Suitable	-
5. Wetlands (inland) -> 5.15. Wetlands (inland) - Seasonal/Intermittent Saline, Brackish or Alkaline Lakes and Flats	Non-breeding	Suitable	-
5. Wetlands (inland) -> 5.16. Wetlands (inland) - Permanent Saline, Brackish or Alkaline Marshes/Pools	Non-breeding	Suitable	-
5. Wetlands (inland) -> 5.17. Wetlands (inland) - Seasonal/Intermittent Saline, Brackish or Alkaline Marshes/Pools	Non-breeding	Suitable	-
5. Wetlands (inland) -> 5.18. Wetlands (inland) - Karst and Other Subterranean Hydrological Systems (inland)	Non-breeding	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	-

Habitat	Season	Suitability	Major Importance?
9. Marine Neritic -> 9.3. Marine Neritic - Subtidal Loose Rock/pebble/gravel	Non-breeding	Suitable	-
9. Marine Neritic -> 9.4. Marine Neritic - Subtidal Sandy	Non-breeding	Suitable	-
9. Marine Neritic -> 9.5. Marine Neritic - Subtidal Sandy-Mud	Non-breeding	Suitable	-
9. Marine Neritic -> 9.6. Marine Neritic - Subtidal Muddy	Non-breeding	Suitable	-
9. Marine Neritic -> 9.7. Marine Neritic - Macroalgal/Kelp	Non-breeding	Suitable	-
9. Marine Neritic -> 9.9. Marine Neritic - Seagrass (Submerged)	Non-breeding	Suitable	-
9. Marine Neritic -> 9.10. Marine Neritic - Estuaries	Non-breeding	Suitable	-
10. Marine Oceanic -> 10.1. Marine Oceanic - Epipelagic (0-200m)	Breeding	Suitable	Yes
10. Marine Oceanic -> 10.2. Marine Oceanic - Mesopelagic (200-1000m)	Breeding	Suitable	Yes
10. Marine Oceanic -> 10.3. Marine Oceanic - Bathypelagic (1000-4000m)	Passage	Unknown	-
12. Marine Intertidal -> 12.1. Marine Intertidal - Rocky Shoreline	Non-breeding	Suitable	-
12. Marine Intertidal -> 12.2. Marine Intertidal - Sandy Shoreline and/or Beaches, Sand Bars, Spits, Etc	Non-breeding	Suitable	-
12. Marine Intertidal -> 12.3. Marine Intertidal - Shingle and/or Pebble Shoreline and/or Beaches	Non-breeding	Suitable	-
12. Marine Intertidal -> 12.4. Marine Intertidal - Mud Flats and Salt Flats	Non-breeding	Suitable	-
12. Marine Intertidal -> 12.5. Marine Intertidal - Salt Marshes (Emergent Grasses)	Non-breeding	Suitable	-
12. Marine Intertidal -> 12.6. Marine Intertidal - Tidepools	Non-breeding	Suitable	-
12. Marine Intertidal -> 12.7. Marine Intertidal - Mangrove Submerged Roots	Non-breeding	Suitable	-
15. Artificial/Aquatic & Marine -> 15.1. Artificial/Aquatic - Water Storage Areas (over 8ha)	Non-breeding	Suitable	-
15. Artificial/Aquatic & Marine -> 15.2. Artificial/Aquatic - Ponds (below 8ha)	Non-breeding	Suitable	-
15. Artificial/Aquatic & Marine -> 15.3. Artificial/Aquatic - Aquaculture Ponds	Non-breeding	Suitable	-
15. Artificial/Aquatic & Marine -> 15.4. Artificial/Aquatic - Salt Exploitation Sites	Non-breeding	Suitable	-
15. Artificial/Aquatic & Marine -> 15.5. Artificial/Aquatic - Excavations (open)	Non-breeding	Suitable	-

Habitat	Season	Suitability	Major Importance?
15. Artificial/Aquatic & Marine -> 15.6. Artificial/Aquatic - Wastewater Treatment Areas	Non-breeding	Suitable	-
15. Artificial/Aquatic & Marine -> 15.7. Artificial/Aquatic - Irrigated Land (includes irrigation channels)	Non-breeding	Suitable	-
15. Artificial/Aquatic & Marine -> 15.8. Artificial/Aquatic - Seasonally Flooded Agricultural Land	Non-breeding	Suitable	-
15. Artificial/Aquatic & Marine -> 15.9. Artificial/Aquatic - Canals and Drainage Channels, Ditches	Non-breeding	Suitable	-
15. Artificial/Aquatic & Marine -> 15.10. Artificial/Aquatic - Karst and Other Subterranean Hydrological Systems (human-made)	Non-breeding	Suitable	-
15. Artificial/Aquatic & Marine -> 15.11. Artificial/Marine - Marine Anthropogenic Structures	Non-breeding	Suitable	-
15. Artificial/Aquatic & Marine -> 15.13. Artificial/Marine - Mari/Brackishculture Ponds	Non-breeding	Suitable	-

Use and Trade

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

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

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)	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)	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 & other problematic species & genes -> 8.1. Invasive non-native/alien species -> 8.1.1. Unspecified species	Ongoing	Majority (50-90%)	Unknown	Unknown
8. Invasive & other problematic species & genes -> 8.1. Invasive non-native/alien species -> 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 -> 2.3.7. Reduced reproductive success		
8. Invasive & other problematic species & genes -> 8.2. Problematic native species	Ongoing	Unknown	Unknown	Unknown
	Stresses:	2. Species Stresses -> 2.1. Species mortality		
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	-	-	-
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	-	-	-
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 -> 2.3.7. Reduced reproductive success		

Conservation Actions in Place

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

Conservation Actions in Place
In-Place Research, Monitoring and Planning
Action Recovery plan: Yes
Systematic monitoring scheme: Yes
In-Place Land/Water Protection and Management
Area based regional management plan: Yes
In-Place Species Management
Harvest management plan: Yes
Successfully reintroduced or introduced beningly: 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 Actions 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
3. Species management -> 3.4. Ex-situ conservation -> 3.4.1. Captive breeding/artificial propagation
5. Law & policy -> 5.1. Legislation -> 5.1.2. National 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 -> 1.5. Threats
1. Research -> 1.6. Actions
3. Monitoring -> 3.1. Population trends

Additional Data Fields

Population
Population severely fragmented: No
Habitats and Ecology
Continuing decline in area, extent and/or quality of habitat: Yes
Generation Length (years): 15
Movement patterns: Full Migrant
Congregatory: Congregatory (and dispersive)

The IUCN Red List Partnership

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