COMMENTS ON IUCN RED LIST CITATION FOR *Anguilla anguilla* (L.)

Revision of 2009 critique, rewritten July 2011 based on IUCN Version 2010.4

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N.B. No formal peer-review of 'ver.3.1' has occurred since sending comments to IUCN in 2009 (to which IUCN has never responded). However, various changes have been made, without explanation, in the latest version (2010.4) compared to the original 2008 and 2010.1 versions. Changes include improvements to English and moving parts of the text, but also include some additions and changes, relevant ones are noted below. This revised critique includes more recent references.

IUCN criteria for critically endangered for the European eel = A2bd+4bd

A. Reduction in population size based on any of the following:

2. An observed, estimated, inferred or suspected population size reduction of >80% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.
(b) an index of abundance appropriate to the taxon
(d) actual or potential levels of exploitation

4. An observed, estimated, inferred, projected or suspected population size reduction of >80% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.
(b) an index of abundance appropriate to the taxon
(d) actual or potential levels of exploitation

KEY COMMENTS

The scientific integrity of the IUCN Red List depends on assessment processes being clear and transparent, appropriately documented and supported by the best scientific information available. There are, however, important errors, omissions and contradictions in the document that severely weaken the case made that the European eel is ***critically endangered*** and is ***facing an extremely high risk of extinction in the wild***

The case for this designation is based on the inferences that *there has been a decline of over 80% in the past three generations (60 years) based on the massive decline in recruitment (95% in 24 years) which is supported by the decline in catch landings of 76% between 1968 and 2005 (37 years).* These inferences can be criticized as follows;-

A. FAO landings data are not a reliable proxy for all European and N. African stocks and do not form a reliable *index of abundance appropriate to the taxon* to indicate a *population size reduction of >80%* (see below).

B. Glass eel recruitment has declined markedly since peaks in the 1980s but time series data for stocks do not show a comparable decline in magnitude over the same time scale (see below). This calls into question whether classical (freshwater) stock-recruitment relationships apply to anguillids

C. It is stated that recruitment and stocks are currently at *historic lo*ws but this is not supported by analyses of pre-1980s data which show large fluctuations have occurred in the past, including regime shifts indicative of major wide-scale shifts in ocean-climate (see below). Furthermore, there is no recognition that eels have survived major oceanic and continental environmental changes over millions of years.

D. Acceptance of the criterion of a *population size reduction of >80% over ..... three generation period (since the 1960s)* (and statements that stock declines and 'recovery' take many decades) rely on an over-estimation that the typical mean generation time across the European eel's distribution range is ~20 years.

E. Important adaptive aspects of the biology of *A. anguilla* (e.g. facultative catadromy) are not clearly and critically reviewed, others are not mentioned at all (e.g. density-dependent sex determination, high fecundity as an adaptation to compensate for high natural mortality and, despite inclusion of a reference source, panmixia).

F. The assessment is based on the assumption that recruitment declines are due to effects of anthropogenic factors acting on spawners, whereas the only statistically significant correlations that have been determined are between recruitment and oceanic factors that could have affected larval survival (e.g. see Miller *et al.*, 2009).

G. The original review is narrow, references are sparse and contains four references and six 'personal communications' from just one person. The review needs more rigorous updating, especially regarding adaptive strategies.

H. IUCN assessments should be based on '*scientific consensus'*, but there is no discussion of views contrary to the conclusion that eels are '*facing an extremely high risk of extinction in the wild*'. For example, Russell Poole of Ireland's Marine Institute and Chairman of the ICES Working Group on Eel stated in Vogel (2010) that *"it is unlikely that the European eel will go completely extinct"* and *"Anyone who talks about extinction is alarmist .... you're talking about fish that spawn multiple millions of eggs".*

I. In this context, it is stated that *'there is no analytical assessment of the state of the [continental] European Eel stock'*. However, such analyses were provided to the ICES Working Group on Eel in 2008 and 2009 (Knights, B. and Bonhommeau, S. (2008) Status and trends in European eel (*Anguilla anguilla* L.) stocks and recruitment in northwest Europe, unpublished). These were summarized in Section 7.5, p.112 in the 2008 Working Group Report (ICES, 2008), but not given any detailed consideration in this or subsequent Meetings.

J. There is also no consideration of similar changes in recruitment in the American (and Japanese) eel and probable causes – and that the American eel has formally been judged in the USA as not endangered

SPECIFIC COMMENTS ON THE TEXT

1. **re. declines in recruitment, yield and stock over 30 years:**
   It is stated that *The species has undergone a sharp decline in both recruitment and yield and stock* (plus the addition in the 2010.4 version) *which will continue into the future.* However,

from the data provided to the ICES Working Group on Eel in 2008 and 2009 for 54 eel stock datasets from NW Europe (indexed to their 1979-94 means), temporal variability was high but 61% showed no significant trends over 1970-2007, 35% showed significant declines and 4% showed significant increases. (Knights & Bonhommeau, unpublished, e.g. see http://www.ifm.org.uk/conference/eels/03_Knights.pdf).

Of 34 time series in the period 1970-2008, inter-annual variability of indices was commonly very high and 14 series (40%) showed significant declines (Fig. 1, Knights unpublished). The plot of geomeans for the combined series indicate that stock levels have not shown changes in magnitude and timing that are clearly related to those in recruitment. Stocks appeared to have been relatively low in the early-1970s but with a number of the series showing marked peaks in the early-1980s, approximately coincident with glass eel recruitment peaks. Average stock levels since then appear relatively stable and similar to those in the early-1970s (Fig.1).

The longest known fishery-independent stock time series, starting in the 1920s, is for the Skagerrak coast (Norway), towards the northerly extent of distribution (Fig. 2). This also shows large inter-annual variations and a peak in 1981, followed by a steep decline. However, the graph indicates that stocks were as low or lower in the 1920s as in recent years (Durif *et al.*, 2010). Analyses of Baltic Sea stocks have declined by ~35% from a peak in the early 1960s in Baltic Sea sites but have been relatively stable since the mid-1970s (Knights & Bonhommeau, unpublished). The Baltic is at the north-easterly edge of the range of the European eel and factors such as a lack of major inflows of sea water from the North Sea in recent decades may be associated with low recruitment of yellow eels.

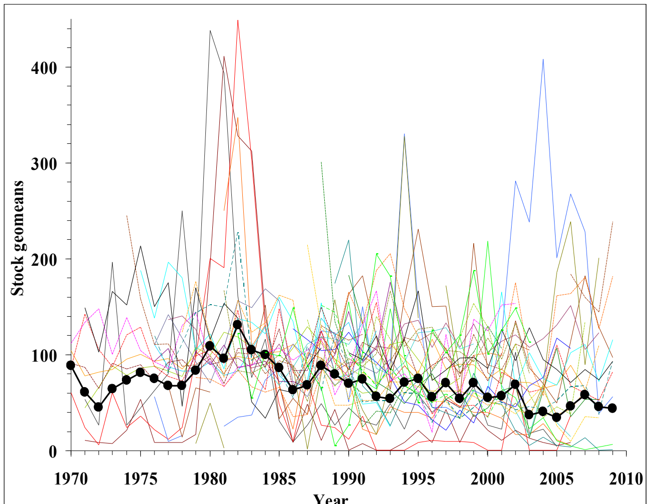

Figure 1 Annual geomeans (1970-2008) for 34 individual stock time series (indexed as % of 1979-94 means) and for combined data (heavy black line).

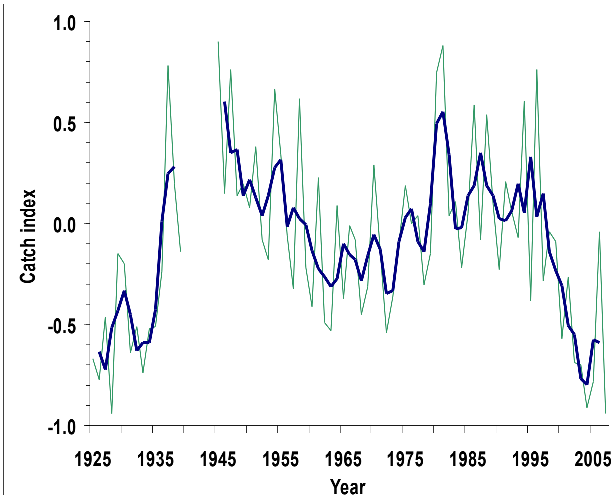

Fig.2 Skagerrak (S. Norway) beach seine survey time series index data for eels. Annual index values in green, 3 year running average in blue (Durif et al., 2010)

2. *Recruitment of glass eels has declined since 1980 and since 2000 is at an historical low at just 1-5% of the pre-1980 levels stock* (plus addition in the 2010.4 version) *showing a 95 to 99% decline.* There is no evidence available to show whether recruitment has declined by such amounts in North Africa or the eastern Mediterranean. Elsewhere, recruitment has declined from peak levels around 1980 but the term *at an historical low* needs qualifying because 23 time series, some stretching as far back as the early-1900s, show that recruitment has fluctuated widely over decadal time scales (Knights & Bonhommeau, unpublished).

Recruitment showed relatively large peaks in the early-1980s and in previous decades, but was relatively low in the 1970s and, very probably, in the early 1900s (e.g. see Durif *et al.*, 2010). Levels have certainly been very much lower in past eras, e.g. during the last ice age (Kettle *et al.*, 2008).

3. **re. the assumption that FAO landings are a direct proxy for stock levels:** this underpins statements such as *stock abundance has declined since the 1960s*, but the IUCN assessment itself notes that *landings cannot be directly linked to population due to* (variations in?) *stocking and harvest effort*. The ICES Working Group on Eel has also recognized that landings data are unreliable (e.g. ICES, 2010). It is, however, stated that *scientific evidence supports this decline*, citing the eel fishery in Lake IJsselmeer in the Netherlands *the possibly only long-term scientific data …. where there has been a gradual decline since 1960 (Dekker 2004a).* It must be noted that the IJsselmeer is a very unusual fishery, being an enclosed (from the former Zuider Zee) and heavily-exploited water body off the southern North Sea where glass eel recruitment would be expected to be naturally relatively low because of the distance from the N. Atlantic larval migration pathways and because access for eels is difficult.

4. The statement in the 2010.1 version *All European catches have decreased, possibly because the eel fishery was developed over this period* has been omitted in the 2010.4 version. Also, the statement *In Norway the catches seem to be stable. (ICES 2002)* has been changed to *However, there is also evidence that in Norway catches seem to be stable over this period (ICES 2002).* No explanations for these changes are given and the meaning and relevance of both of statements in relation to 'Population' is obscure.

5. **re. statements about time scales of stock declines and recoveries**, such as *three generations of the species is* <u>*estimated*</u> *to be 60 years* (changed from the 2010.1 version which stated *three generations = 60 years)*; *The recent decline in recruitment will translate into a future decline in adult stock, at least for the coming two decades (ICES 2006); Noting the longevity of this species, and the extremely depleted state, restoration of the stock is expected to take several generations (Aström and Dekker, 2007), from 60 to >200 years depending on the protection level* (moved from the 'Justification' section to the end of the 'Population' section in the 2010.4 version).

   These statements are based on the assumption that *The generation length of the species* (new words added in version 2010.4 *varies greatly and) ranges from 2 to > 50 years, with a typical mean of 20 years …… (Dekker pers comm. 2007).* The generation time of 20 years is derived from the assumption (from Dekker, 2000) that females silver and emigrate at an age of 16 years and the oceanic spawning and larval migration stages then occupy another four years. However, Åstrom and Dekker (2007) state that this is an *unrealistic assumption* and that the *model is oversimplistic* and *estimates of stock-wide biological characteristics, such as age at maturity, tend to be typical for the northern parts of the distribution of the eel*.

   Thus a 20 year generation time might be the case for slow-growing eels in oligotrophic freshwater habitats at higher latitudes and/or altitudes, but does not take into account panmixia and much shorter generation times in other geographical regions (e.g. North Africa and the eastern Mediterranean) and habitats (e.g. estuaries and coastal waters). Instead, it appears that males mature and emigrate at an average of ~7-8 years and females at ~11-12 years in much of NW Europe but that growth rates are fastest and silvering occurs earliest in productive estuaries (even at higher latitudes) and in warmer Mediterranean habitats (e.g. see Tesch, 2003; Vøllestad, 1992; Yalçin-Özdilek, 2006; ICES, 2009).

6. **re. biology and adaptive strategies**

re. facultative catadromy: conflicting statements are made about habitat distributions, i.e. under **Habitat:** *The species is found in all types of benthic habitats from small streams to shores of large rivers and lakes* and under **Biology;** *The species is catadromous, living in fresh water but migrating to marine waters to breed,* whereas in the **Range Description** it is stated that *Large parts of the population remain at sea particularly* (why 'particularly?) *in the north western Atlantic and Mediterranean*. This point emphasizes the potentially high stocks in brackish, estuarine and coastal habitats (including the Baltic Sea which is not mentioned). Such stocks may well exceed those in freshwaters and many eels show variable patterns of migration between saline and freshwaters during their continental life stage (Daverat *et al*, 2006; Fablet *et al.*, 2007; ICES, 2009). Eels in saline waters also tend to have higher growth rates and shorter generation times than those in freshwaters (e.g. ICES, 2009).

Panmixia and other adaptive strategies: panmixia is not mentioned in the text, although an out-of-date 2001 reference source is given in the Bibliography. More recent studies need reviewing that support panmixia and cover issues of genetic patchiness, sweepstake reproduction and other bet-hedging strategies (e.g. Pujolar *et al.*, 2010; Als *et al.*, 2011; Pujolar *et al.*, 2011).

No genetic bottleneck identified: A species undergoing a drastic reduction in population size and spawning stock abundance would be expected to show a loss of genetic diversity, but no recent genetic bottleneck has been identified by Pujolar *et al.*(2011). Studies by Wirth and Bernatchez (2003), however, suggest that a genetic bottleneck probably occurred around the time of the last ice age, when the distribution and hence effective population size was greatly restricted (Kettle *et al.*, 2008).

7. **re. major threats to survival of the species:** there is no direct quantitative proof that any specific anthropogenic or natural factor has impacted on recruitment and stocks to the extent of endangering the survival of the species throughout its range. For example, *Overfishing for glass eels (mainly in France, Spain, Portugal and UK) and downstream migrating eels (silver eels) across Europe (Dekker pers comm.)* is cited, but there is no specific evidence for recruitment or spawner overfishing to the extent of endangering the species throughout its range.

Causes of changes in overall recruitment and stocks can thus only be predicted from looking for significant spatio-temporal correlations with suspected 'Major Threat(s)'. No such correlations have been determined for anthropogenic factors, but they have been for changes in ocean-climate factors over short and long (historical) time scales. More recent studies need consideration, e.g. see Miller *et al.* (2009) and papers by Durif *et al.* (2010) and Martin *et al.* (2010)

8. **Stock-recruitment relationships:** Classical (freshwater) fish stock-recruitment relationships may not be shown by anguillids, as indicated by the unclear S-R relationships discussed above. Eels are periodic strategists characterized by relatively large and highly fecund marine spawners, producing very large numbers of small eggs to compensate for potentially very

high levels of natural mortality, due to stochastic environmental changes, during a prolonged marine planktonic larval stage (King and McFarlane, 2003; Winemiller, 2005).

9. **Comparisons with assessments for the American eel (*A. rostrata*)**
Given the similarities between the biology and recruitment trends of European and American eels (e.g. see Miller *et al.*, 2009), consideration should be given to the fact that *A. rostrata* has been assessed as 'of Special Concern' (i.e. *may become threatened or endangered because of a combination of biological characteristics and identified threats*) by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC, 2006). It has not, however, been listed 'At Risk' under the Canadian Species At Risk Act. The assessment is based particularly on concerns about declines of recruitment of yellow eels and fishery yields at the extremes of the species range, in the Upper St. Lawrence River and Great Lakes in Canada (i.e. a situation similar to that for the European eel in the Baltic Sea,).

Also, following a rigorous review by the United States Fish and Wildlife Service, *A. rostrata* was not assessed as 'endangered' in the USA under the Endangered Species Act (1973). The main conclusions were that *'On the basis of the best available scientific and commercial information, we conclude that the American eel is not likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range and is not in danger of extinction throughout all or a significant portion of its range.*' (Bell, 2007). The ruling also stated '*Although the interactions are not completely understood, the success of early eel life stages and subsequent recruitment to fresh water is dependant on oceanic conditions, which are subject to natural variation (but) oceanic conditions are within normal variations (and) the American eel is evolutionarily adapted to oceanic variations*'

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