



**UK Glass Eels MSC Assessment
Dry-Run SICA Workshop
Report and Conclusions**

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1. Introduction

Parts of the catchment of the River Severn (the lower Severn, the Wye and the Parrett) support a traditional fishery for glass eels. The eels are used largely for restocking in Lough Neath (Northern Ireland) where they support a yellow and silver eel fishery as well as considerable escapement of silver eels (the reproductive stage of the life history). At the request of UK Glass Eels Ltd., a pre-assessment of the Severn, Wye and Parrett glass eel fisheries was carried out in mid-2008 with the eventual aim of achieving MSC certification. The pre-assessment raised some potential difficulties, particularly with the likely status of the stock, but since the reasons for the apparent stock decline are unknown but highly unlikely to be related to fisheries, the final outcome of the pre-assessment was ambiguous.

Since then, the MSC have introduced a new mechanism by which fisheries can be certified: the Risk-Based Framework (RBF). This framework is applicable to fisheries where full scientific information is lacking, and relies more heavily on stakeholder knowledge, allowing information in the form of a consensus of opinion rather than a formal scientific assessment to be taken into account. The RBF is clearly a useful tool in this case, where data on the stock size are to some extent disputed, as are the likely causes of change.

The key tool used in an MSC assessment under the RBF is a 'SICA' (Scale Intensity Consequence Analysis). Essentially, the SICA relies on assembling a group of experts and stakeholders from all elements of the fishery (i.e. stock assessment scientists, fishermen, buyers, environmentalists etc.) and using a structured discussion to establish a consensus score for the impact of various different activities on the population in question. If no consensus is achievable, the most conservative (i.e. lowest) score is used.

It was therefore decided, in the context of a concurrent large conference on eel fisheries and management, to assemble a group of expert stakeholders to attempt such a SICA analysis for this fishery. The analysis was not part of a formal MSC assessment, but was rather a 'dry-run' to test the likely outcome of a possible assessment in the future. In this sense, it can be regarded as an extension of the pre-assessment process.

A list of the stakeholders who participated in the process is given in Annex 1.

2. Background information

Over the last two decades, there has been increasing concern about the population of the European eel (*Anguilla anguilla*), which is assumed to be significantly depleted compared to historic levels because of falls in glass eel recruitment and fishery yields. The European Union has established a regulation requiring Member States to take action to conserve eels (Regulation number 1100/2007) and CITES has listed the European eel on Appendix II (meaning that international exports of eels and eel products should be

rigidly controlled). Freshwater and wetland habitat loss, obstructions to upstream migration (weirs, dams, flood control structures), climate change, disease, pollution and fisheries may all have played a role in this decline.

Until recently, glass eel recruitment to the Severn estuary had not declined as significantly as in most other important eel catchments (this may be changing with very poor recruitment in 2009; however glass eel recruitment is known to be variable from year to year). The EIFAC Working Group on Eels suggest that the River Severn catchment may be one of the last remaining catchments where there is a significant surplus of glass eels which could be used for restocking (as happens at present to Lough Neath). However, the glass eel fishery (to supply restocking as well as aquaculture facilities) depends on the existence of a market for yellow and silver eels. These markets are under threat because of a perception by consumers of problems with the stock. Thus paradoxically, unless some kind of market for yellow and silver eels can be maintained, glass eel fisheries are likely to cease and this could lead to problems of supply for restocking for conservation purposes. This is the context in which MSC assessment has been considered for this fishery.

3. Use of the ‘Risk-Based Framework’

The MSC standard consists of three principles, which can be roughly summarised as follows:

- Principle 1: Is the target stock in a healthy state?
- Principle 2: Does the fishery impact on the ecosystem or on other species (i.e. by-catch and habitat impacts)?
- Principle 3: Is management precautionary and effective?

Here we are essentially concerned with Principle 1 (since the pre-assessment report concluded that by-catch and habitat impacts in this fishery are very low).

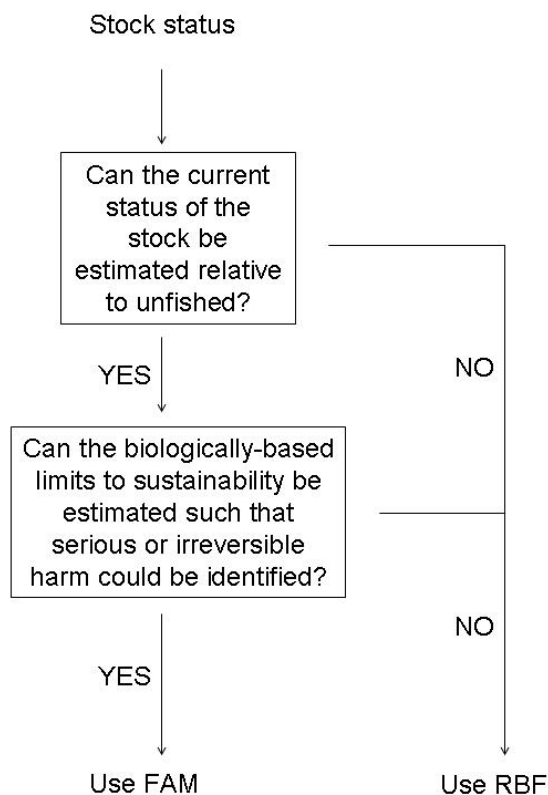
Under the standard assessment methodology set out by MSC, there is a presumption that the scientific model of fisheries assessment and management has been followed: i.e. that the stock biomass has been assessed over time by using fisheries dependent and independent data to fit and verify quantitative population models. This methodology is impossible to follow in the case of eels, because of their complex life history and more or less total lack of information about its marine component (which includes spawning and the first two years of life).

In these circumstances, MSC offers an alternative assessment route, called the ‘Risk-Based Framework’ (RBF). This assessment relies less on quantitative scientific data (estimates of spawning stock biomass, reference points etc.) and more on the consensus view of stakeholders about the impacts of different activities (including the fishery) on the stock, as well as on such data as might be available about the population. Clearly this

approach relies on discussion with a diverse range of stakeholders, including scientists and experts, participants in the fishery, conservation advocates and so on.

The choice of whether to use the RBF or the standard methodology in a given assessment is not a matter of picking ‘whatever seems easiest’ – MSC set out decision criteria, as shown for Principle 1 in Figure 1. Clearly, in this case, since the answer to both questions is ‘no’, the RBF is the appropriate framework.

Figure 1. MSC decision tree to select standard methodology (Fisheries Assessment Methodology ‘FAM’) or RBF.



An analysis under the RBF proceeds in a series of stages, depending on the outcome of the previous stage. The first stage is a type of analysis called a ‘SICA’¹ which is based essential around a structured discussion between stakeholders. The second stage – if the

¹ Scale Intensity Consequence Analysis

outcome of the SICA suggests some level of risk to the stock of moderate or above – is a ‘Productivity-Susceptibility Analysis’ (PSA)². Here we are concerned only with the SICA.

A SICA itself proceeds in several stages.

1. Risk-causing activities: As a first step, the stakeholder group must decide on a list of activities which may have an impact on the population – this will include fishing (possibly various different fisheries) but may also include issues such as pollution, habitat loss and climate change. Risk-causing activities in this case were identified as follows:

- glass eel fishing
- yellow and silver eel fishing
- entrainment in turbines
- disease and parasites
- predation by inland cormorants
- pollution
- habitat loss, either by wetland drainage or by blockage of migration routes so that habitat is inaccessible
- climate change (including oceanographic changes affecting migration routes)

2. Spatial and temporal scale and intensity: The second step is that the stakeholder group consider the spatial scale, the temporal scale and the intensity of each activity in relation to the population. These scores do not feed directly into the final score for the SICA, but they do help to start off the discussion and ease participants into the idea of allocating scores.

3. SICA scoring: The third step is for the potential risk posed by each activity to the population to be scored. This is done by considering four ‘components’ of the population dynamics: population size, reproductive capacity and/or recruitment, age/size/sex ratio and geographic range. The likely impact of each activity on each component is scored separately. Activities can then be ranked according to their likely impact on the population dynamics, the highest risk activities can be identified along with the element of the population on which they act.

4. Spatial and temporal scale and intensity

The spatial scale score depends on the overlap of the activity with the geographical distribution of the stock, as per Table 1.

² A PSA compares the likely productivity of the stock (based on age and size at maturity and reproductive strategy) against its overlap with the fishery (or fisheries in general). The problem with this analysis in the case of eels is that because it only considered fishery impacts it excludes a whole range of other impacts on the stock. Overall, it does not seem to the author to be particularly relevant or useful for eels.

Table 1. Table for scoring spatial scale of each activity relative to geographic distribution of stock.

Overlap of activity with geographic range of stock	< 1 %	1-15 %	16-30 %	31-45 %	46-60 %	>60 %
Score	100	80	60	40	20	0

In scoring spatial scale of activities against eel population distribution, we made two decisions: i) we took the view that the European eel exists as a single, panmictic stock (the majority of experts take this view); and ii) we considered only the continental growth stage component of the geographic distribution, and did not include the oceanic element of the life cycle.

The temporal scale score relates to the frequency with which this activity takes place, over the entire geographic extent of the stock (see Table 2).

Table 2. Table for scoring temporal scale of each activity.

Temporal scale of activities	Decadal (1 day every 10 years or so)	Every several years (1 day every several years)	Annual (1 – 100 days per year)	Quarterly (100-200 days per year)	Weekly (200-300 days per year)	Daily (300-365 days per year)
Score	1	2	3	4	5	6

The intensity of each activity is scored according to Table 3:

Table 3. Table for scoring intensity of each activity.

Score	Description
1	Remote likelihood of detection of activity at any spatial or temporal scale
2	Activity occurs rarely or in few restricted locations and evidence of activity even at these scales is rare
3	Moderate detection of activity at broader spatial scale or obvious but local detection
4	Detectable evidence of activity occurs reasonably often at broad spatial scale
5	Easily detectable localised evidence of activity or widespread and frequent evidence of activity
6	Local to regional evidence of activity or continual and widespread evidence

The stakeholder group scored the spatial scale, temporal scale and intensity of each activity on the list as in Table 4.

Table 4. Scores for spatial scale, temporal scale and intensity of each risk-causing activity. The activities with the highest scores (greatest spatial and temporal overlap and highest intensity) are shown in bold.

Performance Indicator	Risk-causing activities	Spatial scale of activity	Temporal scale of activity	Intensity of activity
Target species outcome	Fisheries for glass eels	2	4	3
	Fisheries for adult eels	5	4	4
	Habitat loss / barriers	6	6	6
	Turbines	2	6	3
	Disease / parasites	6	6	6
	Pollution	2	6	3
	Climate change	6	6	6
	Predation (cormorants)	6	6	4

On the basis of this preliminary ranking, the three activities with highest spatial and temporal overlap and intensity of impact on the eel stock are considered to be i) climate and oceanographic change, ii) disease and parasites and iii) habitat loss and inaccessibility. Behind these in order come: predation by inland cormorants; adult eel fishing, turbines and pollution; and finally glass eel fishing as the least serious. However, these scores act only as a guide for the full SICA analysis.

5. SICA

Each combination of activity and population component was scored according to a SICA consequence table (provided by MSC) – see Table 5.

Table 5. SICA consequence table – used for scoring each activity / component combination. Note that the MSC scores 100, 80 and 60 are (more or less) equivalent to scores of 1, 2 or 3 in the analysis above – the scoring systems are different for purely historic reasons.

Component	MSC score		
	100	80	60
Population size	Insignificant change to population size/growth rate (r). Unlikely to be detectable against background variability for this population	Possible detectable change in size/growth rate (r) but minimal impact on population size and none on dynamics	Full exploitation rate but long-term recruitment dynamics not adversely affected.
Reproductive capacity	No detectable change in reproductive capacity. Unlikely to be detectable against background variability for this population.	Possible detectable change in reproductive capacity but minimal impact on population dynamics.	Detectable change in reproductive capacity; impact on population dynamics at maximum sustainable level; long-term recruitment dynamics not adversely damaged.
Age/size/sex structure	No detectable change in age/size/sex structure.	Possible detectable change in	Detectable change in age/size/sex structure;

	Unlikely to detectable against background variability for this population.	age/size/sex structure but minimal impact on population dynamics.	impact on population dynamics at maximum sustainable level; long-term recruitment dynamics not adversely damaged.
Geographic range	No detectable change in geographic range. Unlikely to detectable against background variability for this population.	Possible detectable change in geographic range but minimal impact on population dynamics.	Detectable change in geographic range; impact on population dynamics at maximum sustainable level; long-term recruitment dynamics not adversely damaged.

The SICA scores for each activity / component combination are given in Table 6. The scores were informed by the spatial, temporal and intensity scores but the analysis was completely separate.

Table 6. SICA scores for each activity / component combination.

Component / activity combination	SICA consequence score from Consequence Table	Rationale
Effect of glass eel fishing on population size	100	Glass eel fishing is very localised. Glass eels have very high natural mortality. No evidence of a stock-recruit relationship for eels.
Glass eel fishing / reproductive capacity and/or recruitment	90	May have detectable impact on recruitment but highly localised; glass eel natural mortality in estuaries and rivers is very high.
Glass eel fishing / age/size/sex structure	80	Possible localised impacts due to density-dependent sex determination (although perhaps compensatory rather than negative?)
Glass eel fishing / geographic distribution	100	No effect – fishing has not extirpated eels from any part of the distribution. There is no homing to particular river systems.
Effect of adult eel fishing on population size	90	Adult eel fishing is also relatively localised; it may have detectable impact but only in a few places.
Adult eel fishing / reproductive capacity and/or recruitment	90	There have been localised detectable impacts in some places (Ijsselmeer, Baltic, Shannon catchment) but these are considered unlikely to affect

		recruitment
Adult eel fishing / age/size/sex structure	100	No plausible mechanism for effect
Adult eel fishing / geographic distribution	100	No effect – fishing has not extirpated eels from any part of the distribution. There is no homing to particular river systems.
Effect of habitat loss / barriers on population size	60	Considered highly likely to have had an impact (magnitude of impact depends on baseline since wetland loss started in 17 th century or before) but not considered by itself to be at an unsustainable level.
Habitat loss and barriers / reproductive capacity and/or recruitment	60	Probably has had negative impact but lack of consensus on links between continental population size, spawning stock biomass and glass eel recruitment (no good evidence for a stock-recruit relationship – environmental factors are probably more important). It is probably impossible to say for sure.
Habitat loss / age/size/sex structure	100	No likely effect – there is still a mix of systems producing mainly females vs. mainly males (e.g. E. England vs. W. England), related to the relative extent of recruitment (as dictated by proximity to oceanic larval migration pathways) and hence stock density
Habitat loss and barriers / geographic distribution	70	Eels have lost part of continental distribution due to habitat loss and barriers but this is not considered unsustainable by itself. The majority of the group thought 80 the best score so 70 is probably precautionary.
Turbines / population size	90	May have detectable impact but only in a few places – best estimate is that roughly equivalent to adult eel fishery
Turbines / reproductive capacity and/or recruitment	90	Probably detectable impact but localised.
Turbines / age/size/sex structure	100	No likely mechanism for effect
Turbines / geographic distribution	100	No extirpation from terrestrial distribution due to turbines – impact is on silver escapement

Disease / population size	90	Detectable levels of <i>Anguillicola</i> in most river systems but infection is not fatal (at least in freshwater / estuaries). Other non-fatal diseases also exist but are very poorly known.
Disease / reproductive capacity and/or recruitment	90	Not generally fatal (at least in freshwater / estuaries) – but lack of consensus on this score because effects of <i>Anguillicola</i> during marine part of silver eel migration/spawning not really known.
Disease and parasites / age/size/sex structure	100	No likely mechanism for effect
Disease / geographic distribution	100	Diseases mainly not fatal – may have impact on reproduction but no impact on distribution because no homing
Pollution / population size	90	Not fatal (at least in freshwater / estuaries)
Pollution / reproductive capacity and/or recruitment	80	Not fatal but may affect levels of body fat in adult eels leading to higher failure rates for migration and spawning (but this has never been measured). Possible role in endocrine disruption also not well understood. Pollution is only severe in localised areas.
Pollution / age/size/sex structure	100	No mechanism for effect
Pollution / geographic distribution	100	As above
Oceanographic and climate change / population size	< 60	Considered probable main cause of decline in populations, although other impacts probably also contributed.
Oceanographic and climate change / reproductive capacity and/or recruitment	<60	Considered likely to affect spawning and/or migration of leptocephalus / glass eels towards continent – important cause of decline in recruitment? Lack of evidence for stock-recruit relationship leads to hypothesis that size of recruitment into rivers determined largely by marine environmental factors?
Oceanographic and climate change / age/size/sex structure	< 60	Probable cause of decline in recruitment – leading, via density-dependent sex determination, to change in sex ratio in estuarine and

		freshwater habitats
Oceanographic and climate change / geographic distribution	< 60	Loss of eels in Baltic and possibly Eastern Med. thought likely attributable mainly to this cause
Predation / population size	90	May have detectable impact in some places but fairly localised (N. Germany / Low Countries)
Predation / reproductive capacity and/or recruitment	90	Possible impact but localised and depends on uncertain stock-recruit relationship
Predation / age/size/sex structure	90	Possible impact but localised?
Predation / geographic distribution	90	Considered unlikely but possible that eels extirpated from anywhere due to predation

6. Discussion and conclusions

Scores and rankings

Table 7 shows the means score of each impact across the four population components, in order of perceived severity. The stakeholder group considered that the decline in eel populations and recruitment could be put down mainly to climate change, which was likely to be causing an impact ranked as major, severe or catastrophic³. The likely mechanism for this impact was via an impact on the marine component of the life cycle, which includes two long and (presumably) risky migrations; one as adults from the European continent to the Sargasso Sea and one as leptocephalus larvae and glass eels in the other direction. Historical habitat loss (or unavailability due to barriers) was also considered to have had an important impact ('moderate'). The other risk-causing activities were not considered by themselves to have had significant impacts on eel population size or dynamics.

Table 7. Mean score for each impact-causing activity, with interpretation of score according to MSC consequence table.

Impact-causing activity	Mean score	Interpretation
Adult eel fishing	95	Impact on population dynamics almost negligible
Turbines	95	Impact on population dynamics almost negligible
Disease	95	Impact on population dynamics almost

³ The spatial, temporal and intensity scores (1-6) are also associated with a description (1=negligible, 2=minor, 3=moderate, 4=major, 5=severe and 6=catastrophic). These scores are then associated with MSC scores in the SICA as follows: 1=100, 2=80, 3=60, 4, 5 or 6 = <60; i.e. an MSC score of <60 can be described as an impact which is anywhere from major to catastrophic. It should be noted, however, that in this case the stakeholder group expressed its concern about the appropriateness of these terms.

		negligible
Glass eel fishing	92.5	Impact between minor and negligible
Pollution	92.5	Impact between minor and negligible
Predation	90	Impact between minor and negligible
Habitat loss	72.5	Impact on population dynamics moderate
Climate change	<60	Impact major, severe or catastrophic

Some of the population components may be considered to be more important than others – for example, impacts on population size and reproductive capacity / recruitment were generally considered by the stakeholder panel to be more likely than impacts on age/size/sex structure and geographic distribution (because of features of eel life history, including semelparity, late and density-dependent sex determination, panmixia and a lack of homing by young to parental rivers). If population size and recruitment are considered alone, the ranking of activities according to their impacts is slightly different (see Table 8). Glass eel fishing is considered less serious, while most other issues are considered slightly more serious. However, each issue retains more or less the same interpretation, and the two issues considered to have impacts which are moderate or above remain the same: habitat loss and climate change.

Table 8. Mean score for each impact-causing activity including only impacts on population size and recruitment, with interpretation of score according to MSC consequence table.

Impact-causing activity	Mean score	Interpretation
Glass eel fishing	95	Impact almost negligible
Turbines	90	Impact between minor and negligible
Disease	90	Impact between minor and negligible
Adult eel fishing	90	Impact between minor and negligible
Predation	90	Impact between minor and negligible
Pollution	85	Impact minor
Habitat loss	60	Impact moderate
Climate change	<60	Impact major, severe or catastrophic

Conclusions in regard to MSC assessment of the Severn glass eel fishery

Overall, regardless of how the overall score is calculated, the one issue which (according to this analysis) would block a successful certification of the Severn glass eel fishery by MSC, were it to be included, is climate change. Previous discussion with MSC suggests that experts should consider all anthropogenic impacts in their analysis, but not ‘natural’ impacts. While climate change is commonly supposed to be anthropogenic, it is not clear that this was the intention of the MSC policy – indeed, it is not clear what would constitute a ‘natural’ impact under this interpretation. MacAlister Elliott and Partners has requested that MSC clarify their policy in regard to climate change – i.e. to state whether or not a fishery can be certified when major impacts on the stock have been caused by climate change. It appears that MSC policy on climate change impacts is still under consideration, and therefore (unfortunately) this exercise has not provided any certainty

as to whether an MSC assessment is likely to succeed, although it has narrowed down the main issue to some extent.

Habitat loss and barriers to access was also considered to be an issue of some importance by the stakeholder panel. With a score of 60, this issue would not block certification, but would require that a condition be put on certification to require action to be taken to improve the situation. It is not clear what the individuals and organisations associated with a glass eel fishery could do toward the improvement of access to habitat in the Severn catchment, but probably the condition would involve some lobbying and/or funding or in-kind support for research on the issue.

Composition of stakeholder group

Informally, MSC have questioned whether the relatively high scores (low impacts) given to the fisheries activities arose from the composition of the stakeholder group. It is true that this 'dry-run' SICA analysis was a private activity (i.e. by invitation rather than public announcement) and therefore not open to all stakeholders. However, it seems unlikely that the representation as it was would have led to any significant bias in favour of particular activities or against others. The bias of the stakeholder panel in terms of representation was largely in favour of scientists, who would (it is hoped) have had an objective view of the likely role of different activities. One person associated with the glass eel fishery was present, as was one person associated with a conservation NGO – neither played a major role in the scoring.

Conclusions

1. The process of the SICA analysis worked very well and produced a surprising amount of consensus between stakeholders on a difficult subject about which many questions remain to be answered;
2. Climate change emerged as the key factor which threatens eel populations according to this stakeholder group. Climate change impacts were the only impacts which received a low enough score to threaten MSC certification. Habitat loss emerged as a secondary but still important factor. Other potential risk-causing activities were not considered to be serious.
3. As a result of this outcome, the fishery is obliged to await clarification from MSC about their policy on climate change impacts.

Annex 1: Composition of stakeholder group

Name	Organisation	Role / organisation
Dr Jo Gascoigne	MEP	Facilitator
Andrew Kerr	SW Wildlife Trusts	Conservation NGO
Peter Wood	UK Glass Eels	Glass eel buyer
Dr Robert Rosell	Agri-food and Biosciences Institute, Northern Ireland	Scientist and manager
Dr Miran Aprahamian	Environment Agency	Scientist and manager - responsible for UK Eel Management Plans
Ayesha Taylor	Environment Agency	Scientist and manager, UK Eel Management Plans
Dr Brian Knights	King's College London (retired)	Research scientist
Dr Christopher Moriarty	Department of Fisheries, Ireland (retired)	Scientist – former chair of EIFAC Working Group on Eels