Stocking European Eels
(Anguilla anguilla)

The Eel Manual - GEHO0211BTMX-E-E

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Published by:

Environment Agency
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1 Introduction

1.1 Background

The European Commission has initiated an Eel Recovery Plan (Council Regulation No.1100/2007) to try to return the European eel stock to more sustainable levels, Article 7 describes the measures concerning stocking (DEFRA, 2009).

The 2007 Regulation requires that at least 35% of the commercial catch of eels of less than 12cm is made available for restocking. This requirement will rise to 60% by 2013.

However, scientific evidence evaluating the efficacy of stocking remains scarce. Most studies have focused on the contribution of stocking to commercial fisheries.

If stocking is to play a major role in the recovery of eel populations, it will be necessary to make best use of the scarce and dwindling elver population. Stocking or translocation can be used to provide access to previously unattainable areas. However, the main advantages of artificial rearing are realised by removing the natural bottlenecks that may reduce survival rates in the wild.

By minimising the effects of domestication it is possible to achieve an overall increase in lifetime fitness.

The ICES/EIFAC Working Group on Eels(WGEEL) has been exploring this issue for some years. The group recently published its findings (ICES, 2009) and concluded:

- There is clearly insufficient quantitative data from targeted studies of the performance of stocked eel in open wild environments. and more data would help considerably in formulating advice on if, when, where and how much to stock.
- Batch marking of stocked eels should be incorporated into stocking projects to increase conclusive traceability.
- Future tracking studies should be expanded to include the ocean migration of silver eels known to be derived from stocking.
- A best practice manual on capture, storage and transport of glass eel is urgently required.

However, there have been some encouraging reports of contributions of stocked eels to fisheries. Studies have reported survival rates for elvers ranging from 3.5 to 20% (Shiao *et al.*, 2006, Pedersen,1998, Andersson and Sanstrom, 1992) and a survival rate of up to 80% for yellow eels (McCarthy *et al.*, 1996). This demonstrates that the concept of stocking to increase silver eel escapement warrants further urgent investigation and evaluation. A summary of the most up-to date knowledge on the survival rates of stocked eels is presented in the latest report from the WGEEL (ICES, 2009).

This guidance document is the result of a two-day workshop to collate best practice on eel management. The guidance is available to anyone embarking on an approved and strategic programme of eel/elver stocking for the purpose of supporting the implementation of the Eel Management Plans.

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This guidance document should be read in conjunction with the Environment Agency Operational Instruction Fish Stocking and Removals and specifically the Eel and Elver Stocking Supporting Document (In preparation).

2 Site selection and prioritisation

2.1 Introduction

These guidelines are designed to help choose freshwater sites for stocking with European eel.

The guidelines present a series of increasingly flexible criteria applied at a range of spatial scales (from basin, to watershed, to reach).It is important to be confident that the conditions which make a site suitable for stocking will continue to be met, either for the duration of the stocking programme, or for the residency of the eels in that freshwater site (whichever is longer).The Habitat selection table in Appendix 1 guides users through the decision process.

The freshwater ecology of eel is poorly understood so monitoring should be incorporated in stocking programmes whenever possible. Because of the length of time it takes eel to mature and recruit to the spawning population (up to 14 years for males, 20 years for females), monitoring should ideally be long term.

Monitoring the results of different stocking schemes will allow us to continually refine best practice and make stocking programmes more effective.

It may be possible to secure partnership funding for stocking programmes, but such funding is often tied to a particular site. For example, a conservation group may offer match funding for stocking their nature reserve. All such opportunities should be judged on a case-by-case basis, but all stocking sites should meet the criteria below. Consider very carefully any decision that would mean stocking a large number of eel (paid for by partnership funding) at a site that is less than ideal, rather than stocking fewer eel (paid for from one source) in an ideal location.

2.2 At the river basin scale

2.2.1 Core criteria

At the basin scale, stocking locations should meet the following core criteria:

- Water quality parameters must be appropriate to enable eel migration:
  - pH 5.0 to pH 8.0;
  - dissolved oxygen >2.0 mg l^{-1} at 15 ^{o}C;
  - low un-ionised ammonia <0.2 mg l^{-1};
  - low risk of chronic or episodic pollution events.
- Silver eel must have unobstructed access to the sea.
- There must be a low risk of entrainment for migrating silver eel.
- Stocking eel needs to be politically, socially and ecologically acceptable. Avoid sites where you are likely to face strong opposition from fishing or conservation interests.

- Minimise the potential effects of eel stocking on other sensitive species (such as white-clawed crayfish, salmon, sea trout, bullhead, spined loach).

River basins meeting the above core criteria should be prioritised based on the following considerations:

2.2.2 Diversity and quality of habitat and/or resources

Waterbodies should contain the wide range of physical habitats used by eel such as shallow areas with weed for smaller eels and cobbles and boulders with refuge space for larger eels.

There should be a diverse macro invertebrate community, in order to provide the stocked eel with sufficient food resources.

2.2.3 Longitudinal connectivity

Eels should be able to move relatively freely through the channel network, so that they can access the range of habitats used during freshwater residency.

2.2.4 Lateral connectivity

During floods, eel forage for terrestrial food (such as earthworms and snails)in floodplains and off-channel habitats. Basins with functional floodplains will allow eel access to these important habitats.

2.2.5 Lake habitat

Lakes can be productive eel habitat. If basins have natural or artificial lakes with adequate downstream passage, they are likely to recruit high numbers of silver eel.

2.2.6 Fishing pressure

Losses of stocked eel to commercial fisheries should be minimised. All other factors being equal, basins with lower fishing effort should be prioritised over basins with high fishing effort.

2.2.7 Partnership opportunities

Work to develop stocking programmes that involve collaborations between land-owners, conservation and fishing groups, and other governmental and non-governmental partners.

2.3 At the site scale

When stocking sites within basins consideration should be given to the following:

2.3.1 Low eel density

Stocking should only take place at sites where eel densities are well below carrying capacity in terms of number (< 2 eels/ m^2) and biomass (<0.2g/ m^2).

2.3.2 Eel-free reaches

Eel-free reaches that are above artificial barriers to upstream migration are ideal for monitoring. This is because there is no confusion between ‘naturally-occurring’ eel and stocked eel. Also, downstream migrants will recruit freely to the larger population.

2.3.3 Experimental design

Stocking programmes should aim to incorporate some of the fundamental knowledge gaps regarding eel behaviour and biology. This will help to continually refine best practice.

Some aspects of a stocking programme may affect early growth and survival, those requiring further study include:

- time of stocking (day, night, season);
- stocking age (glass eel, elver or on-grown eel)
- predators, prey and competitors.

3 Stocking density

3.1 Rivers

3.1.1 Key elements of Best Practice

When stocking elvers and/or eels year on year at the same river sites stock at a maximum density of 6 elvers m^{-2} each year in areas where natural mortality is high. Stock at up to 2.5 elvers m^{-2} where mortality is expected to be low.

Where stocking of elvers and/or eels is planned as a single event per eel generation at any specific river location stock at densities of up to 12 fish m^{-2} in areas where natural mortality is high, and up to 5 fish m^{-2} where mortality is expected to be low.

Note – these numbers are based on stocking glass eel/elvers. They allow for the relatively high early mortality of such small eels. Stock older, larger eels at lower densities in order to achieve the equilibrium density target. Data are not currently available to specify this figure.

These stocking densities are based on the assumption that there are no eels already present at the stocking site. Where 'natural' populations exist, reduce the numbers stocked accordingly.

3.1.2 Background information

3.1.3 Carrying capacity

In 2006, WGEEL discussed the concept of the carrying capacity of a waterbody in relation to decisions to stock eel. Carrying capacity is defined as the maximum density or biomass that the habitat can sustain under average conditions. However, the carrying capacity of eel is difficult to quantify because eel production is so variable in terms of numbers versus biomass, and sex-related growth and age/size at silvering. For example, a reach could produce high densities of eel which are mostly male and migrate at low individual weights. In such an example, the biomass might be less than if the reach had produced fewer but larger females.

In the tributaries of the lower Severn, for example, Aprahamian (2000) found eel densities ranging from 0.12 to 1.14 m^{-2} and biomass ranging from 2.56 to 25.24 gm^{-2}. As there was no relationship across the sampled sites between growth and either density or biomass, the author suggested that these sites were close to or at their carrying capacity. Williams & Aprahamian (2004) therefore concluded that carrying capacity occurs at densities above 2 yellow eels m^{-2}. If eels are stocked above carrying capacity, this will not increase the production of silver eel. Therefore eels should be stocked at densities that are well below carrying capacity.

3.1.4 Ratio of male to female

Although the physiological mechanisms for gender differentiation in eels (reviewed by Davey and Jellyman, 2005) are still unclear, there is strong evidence that it is density driven. As we have no information on the optimum sex ratios for eel reproduction we assume that we should aim for a silver eel sex ratio of at least unity and probably favouring production of females. Comparison of mean yellow eel densities and sex ratios for 14 rivers in England and Wales (Bark *et al.* 2007) suggests that females dominate in rivers where yellow eel mean densities are less than 0.2 eels m^{-2}.

3.1.5 Age of eels stocked

The density 'targets' are based on local populations of yellow eels that will include eels of different ages. However, recent eel stocking in the UK has typically been with glass eel and pigmented elvers. The natural mortality of small eels is relatively high under normal conditions. So we can stock glass eel or pigmented eel at a higher density in order to produce an average yellow density of 0.2 eels m^{-2} several years later.

The Eel Stocking Assessment Tool (ESAT)allows the user to estimate this higher stocking density. Developed by Cefas for the Defra Fisheries Challenge Fund (Walker et al., 2009), this tool models the future mortality of the stocked eels over time. The model uses plausible values of natural mortality rates for wild eels and is based on an assumption that eels grow at a rate of 2.5 cm per year. It calculates the number of glass eels that need to be stocked in order to achieve an average local yellow eel density of about 0.2 eels m^{-2}.

We have done these calculations for annual stocking and for a single stocking event. If stocking takes place each year, the model predicted that a 3 yr stocking programme of 0.3 glass eel m^{-2} would produce 0.2 yellow eels m^{-2} after 5 years. A single stocking event at a stocking density of 1.2 glass eel m^{-2} gives the same target density after 5 years.

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3.2 Lakes

3.2.1 Background

Although there are reports of eel stocking in lakes to support fisheries, we still know very little about the relative production rates of eel stocked at various densities in lakes. The most recent, and most geographically relevant, study looked at yellow and silver eel production from eel stocked into Lough Neagh in Northern Ireland.

A model developed from the production data for 15 annual stocking events suggests that output (both for females and for both sexes) is maximised at around 150 to 200 glass eel per hectare, and declines at higher stocking densities (ICES, 2007).

Note – Lough Neagh is a highly eutrophic and relatively shallow, warm lake where eel production is relatively high.

A number of studies have shown a positive correlation between stocking juvenile eels in lakes and increases in silver eel escapement (Kangur *et al.*, 2002, Psuty and

Dragonik, 2008). There have also been reports of some phenomenal contributions made by stocked eels to fisheries, especially in lakes. These have ranged from a 3.5 to 20 % survival rate for elvers (Shiao *et al.*, 2006, Pedersen, 1998, Andersson and Sanstrom, 1992),and up to 80 per cent survival for yellow eels (McCarthy *et al.*, 1996).

At present, there are no similar analyses for oligotrophic lakes of the effects that density has on eel production. This area requires urgent research.

3.3 What life stage to stock

The contribution of stocked eels to the yellow eel population (and silver eel escapement) is governed largely by their survival and growth. It is therefore possible to maximise survival and growth by on-growing glass eels/elvers before stocking, rather than releasing them immediately. The benefits of this approach may more than offset the extra costs of holding glass eels/elvers.

However, Klein Breteler (1994) concluded that culturing glass eels to juvenile size increases costs by four to 12 times compared to direct stocking. He reported that the advantages in survival and growth rates were only marginal. White and Knights (1997) suggested that any initial growth advantage is lost after about five to six years. From these observations, Williams and Aprahamian(2004) concluded that the most cost-effective source of stocking material are glass eels, which may give returns equivalent to stocking with yellow eel.

The highest reported survival rates (up to 75 %) have been from stocking of yellow eels, mainly into lakes (ICES, 2009) although no comparison is made of the extra cost involved in rearing them. ICES (2009) also reported studies suggesting that stocking eels into small streams was of limited value due to the low re-capture rates.

Our understanding of the relative merits of stocking with various sizes of eel is still very limited and this is an area that warrants continued consideration and urgent research.

4 Welfare/husbandry and culture

4.1 Introduction

This chapter looks at the welfare considerations for obtaining, moving, holding and culture of the European eel (*Anguilla anguilla*).

There are three main considerations:

- removal/handling;
- transport/translocation;
- holding facilities/culture systems.

4.2 Sourcing eel for restocking

On the basis that 35% (rising to 60% by 2013) of the commercial catch of glass eel less than 12cm must be made available for restocking, the easiest route to obtain eels and elvers for restocking is currently to purchase them from one of the glass eel/elver dealers.

The hand-held dip net is the principal device used to catch glass eels. There are usually few mortalities with this method (P. Wood, pers. comm.).

4.3 Transportation or translocation

From capture at source to end-user glass eels have a shelf life of approximately 3 weeks. This can be reduced to 1 week or extended to 5 weeks depending on the standard of husbandry methods and environmental parameters of holding and transportation equipment.

Transport by road is similar to other aquatic species where pH, dissolved Oxygen, temperature and metabolic by-products have to be closely monitored.

- During transport temperatures must be maintained at a minimum 4ºC otherwise significant mortalities may occur.
- During transport dissolved oxygen levels must be maintained at a minimum of 80% saturated.
- All road transport systems should have pH, temperature and dissolved oxygen monitoring equipment as standard.

4.4 Holding facilities and culture systems

4.4.1 Dissolved oxygen

In intensive culture systems dissolved oxygen is often the most critical factor and as such should be monitored closely. In order to achieve optimal feeding and growth, oxygen concentrations should be kept above 5mg/l. (Rowachai *et al.*,1986).

In intensive feeding conditions with a temperature of 25ºC oxygen levels should be maintained at 100%.

Note – although intensive eel culture systems use fairly well-developed technology, it is difficult to avoid some mortality (Gousset, 1990).

4.4.2 Temperature

Although eels can tolerate a wide range of temperatures, intensive culture systems will maintain temperatures between 23ºC and 26ºC to achieve optimum growth (Tesch, 1999). At temperatures below 4ºC, significant mortalities can occur.

4.4.3 pH

Eels can tolerate a wide range of pH, however the optimum is 7 - 8(Tesch, 2003). In intensive production systems, the pH is kept below 6 to minimise the risk of ammonia toxicity (Gousset, 1990).

4.4.4 Suspended solids

The removal of suspended solids is critical in intensive aquaculture. Typically, filtration is carried out down to 40µm with a mechanised drum filter. This level of filtration will also remove the eggs of *pseudodactylogyrus* sp, reducing the prevalence of this parasite.

4.4.5 Ammonia

Ammonia is the main end product of protein metabolism. It is vital to control ammonia in eel aquaculture as it can affect growth and condition at levels below lethal toxicity. Close monitoring of the daily feeding regime can reduce the build up of excess ammonia. According to Yamagata and Niwa (1979) and Sadler (1981), maximum concentrations of un-ionised ammonia should not exceed 0.5-1.0mg/l.

4.4.6 Handling

Eels must be handled with care in order to avoid skin abrasions which can lead to a variety of secondary parasitic infections.

Eels should be handled with as little water as possible. and preferably either pumped or piped during movement. The most efficient culture systems will have a series of interconnecting pipes between tanks for this purpose. This is considered to be very important for eel welfare.

4.4.7 Grading and sorting

In intensive culture systems, eels of the same age can show a wide range of sizes and weights within a relatively short period. Without management, sizes could range from 0.5g to more than 500g in the same year class. This can lead to poor growth rates and cannibalism. Therefore, it is essential that grading is carried out at regular intervals.

4.4.8 Tanks

Tanks for glass eels culture are usually made from glass-reinforced plastic. The tanks need to be 1 to 5m³ for smaller fish and 10 to 30m³ for growers. Tanks for all age classes need to be self-cleaning to avoid the possibility of damage to the stock through mechanical cleaning methods.

4.4.9 Stocking density

The appropriate stocking density may depend on:

- the type of holding facility;
- the facility's technical capabilities such as the available oxygen levels and water flows.

Tesch (1999) considered the following stocking densities to be optimal in culture systems:

Life stage	Density (kg/m³)
Glass eels	5 - 10
Eels 5-25g	150
Eels <150g	250

It is well documented that very low stocking densities are counterproductive in eel culture, as territorial and hierarchical behaviour can begin to occur (Tesch 1999).

4.4.10 Feeding

For glass eels cod roe is used for first feeding at temperatures above 20ºC. Several days later a mixed moist pellet containing cod roe and commercial diet can be fed. After 21 days the largest glass eels are graded out and can be moved from the moist pellet onto dry crumb feed. The small fish can be re-weaned on cod roe. This process can be repeated up to three times to achieve high survival rates.

4.4.11 Biosecurity

Given the unknown nature of some of the eel pathogens in the wild (see section 5), biosecurity must be of highest priority in any transport/translocation or eel culture system.

All equipment, vehicles, tanks, personnel and clothing must be thoroughly disinfected before and after any contact with eels and critical control points should be established at all rearing/holding facilities.

5 Disease

Parasites, pathogens and contaminants can severely affect the health, reproduction and survival of eel. However, our understanding of how these pressures affect UK eel remains poor. It is important to give careful consideration to eel health when sourcing or introducing eel as part of stocking programmes.

5.1 Eel parasites

The most widely researched eel parasite is the introduced swim bladder nematode *Anguillicoloides crassus* (*A. crassus*). Heavy infections of this parasite can:

- reduce eels' tolerance to environmental stressors;
- disrupt normal swim bladder function;
- severely reduce the proportion of eels contributing to recruitment (EELREP, 2005; Palstra *et al.*, 2007).

A. crassus is now widespread across England and Wales (Kirk, 2003), and the opportunity for control of this parasite may have passed. Although we would recommend seeking *A. crassus* free elvers for introductions, it is likely that eel will face a risk of infection in the receiving waters. This may present a significant threat to the spawning success of returning adult eel, but it may not affect the achievement of the required escapement of 40% of historic silver eel.

The non-native status of other eel parasites, including the monogenean gill flukes *Pseudodactylogyrus bini* and *P. anguillae* ,and the crustacean gill parasite (*Ergasilus gibbus*). Although heavy infections of these parasites are known to cause significant gill damage (Kennedy, 2007), more work needs to be done on their pathological significance for eel populations.

Eels are also host to a wide range of native parasites. More than 60 species have been recorded from eel in England and Wales, with examples from most major taxonomic groups (Kirk, 2000). Although few of these may cause serious disease in wild eel, the action of stocking or growing on may increase their disease potential. Thus, there is a need to be aware of the parasite fauna of eel in order to evaluate disease risks from eel stocking activity.

5.1.1 Recommendations

- Health checks must be carried out on all elver movements undertaken by the Environment Agency. These should follow the standard protocols set out for Section 30 (Salmon and Freshwater Fisheries Act fish movement control) examinations.
- Health checks should recognise that the parasite fauna can change and that elvers spend more time in the river. Health checks should be batched to ensure they remain representative of the fish moved.
- To ensure health checks are representative, the source river must be recorded.

5.2 Eel viruses

There are a number of viruses that can influence eel survival and spawner quality (Haenen *et al.*, 2009). Attention has focused on:

- Eel virus European (EVE);
- Eel virus European X (EVEX);
- Herpes virus Anguillae (HVA).

These viruses are known to occur in other parts of Europe (van Ginneken V *et al.*, 2004). However, their presence, prevalence and distribution in UK eel are unknown. The EVEX virus was found in UK eel in 1984, but these infections were confined to culture facilities.

It is well recognised that of the movement of fish presents the greatest risk of transferring disease from infected localities. However, viruses can be difficult to detect particularly in non-diseased fish.

Most eel viruses have specific temperature ranges in which they are active. They may not affect healthy eels in freshwater. Fish can therefore act as sub-clinical 'carriers' of viruses, with disease outbreaks occurring only during periods of stress. For eels, long-term migrations can certainly be considered stressful.

A number of viruses are known to hinder migration success, cause disease and reduced survival under experimental conditions(Ginneken *et al.*, 2005).

5.2.1 Recommendations

- When stocking any site, source elvers from the nearest viable stock.
- Stock each receiving water from a designated single source. Do not change this source, even if there are times when elvers are not available.
- Collating eel populations from different sources before stocking should not be undertaken.
- Don't stock with elvers sourced from outside the UK.
- Growing on of elvers may give the added value of providing a quarantine opportunity. It may even provide a chance to stress test batches of elvers for viral diseases.

5.3 Bacterial pathogens

A number of bacterial pathogens have been isolated from UK eel. Most of these are known to be secondary infections. They cause disease in eels already weakened by other factors and stressors. Examples include *Aeromonas spp* (in particular *A. hydrophila*), *Pseudomonas spp* and *Vibrio spp*. Bacterial diseases generally occur at low levels in wild fish populations. However, greater losses have been associated with:

- very hot, dry summers/autumns;
- eels subjected to poor environmental conditions
- the build up of eels behind barriers to migration.

5.3.1 Recommendations

The bacterial diseases listed may not cause direct problems in terms of disease distribution. However they may cause difficulties to fish grown in culture. It is important to have a good understanding and awareness of the potential threats. Although most problems can be avoided with good system design and adequate husbandry, antibiotic treatments under veterinary supervision may sometimes be useful.

5.4 Contaminants

Eels are susceptible to a range of contaminants, due to their long somatic growth phase and the remobilisation of fat reserves during spawning migrations (Pierron *et al.*, 2008).

There is a growing awareness that contaminants can disrupt many important biological functions (Geeraerts and Belpaire, 2009), including:

- reproductive development;
- swimming performance;
- the nervous system;
- immune responses;
- endocrinology.

The concentrations and distribution of contaminants within aquatic environments therefore hold important implications for sourcing healthy eels and the prioritisation of suitable stocking sites. Information on contaminants in UK eel is relatively sparse and further studies are urgently required to identify good and poor localities to provide informed management options.

5.5 Legal issues

Keeping elver batches separate before stocking to ensure accurate records of their source is a legal requirement for two reasons:

1. Under the Aquatic Animal Health Regulations (AAHR) 2009, it may be illegal for dealers to bring together (eel stations) different populations of eels before stocking.
2. The source of introduced fish must be known and is a requirement of annual site records inspection carried out by Cefas (Centre for Environment, Fisheries and Aquaculture Science).

For these two reasons, the Environment Agency requires a consignment note (see Appendix 4) to accompany any elver transport. Mixing of elver batches at the holding station would make it impossible to state the origin of fish to be introduced during any proposed stocking.

6 Risks associated with stocking

6.1.1 Disease transfer

There are many pathogenic organisms associated with eels that may cause disease (see Section 5). The main risk from stocking is the inadvertent spreading of disease by transferring elvers or eels across catchments without screening. This has been observed in the global trade in live eels (van Ginneken *et al.*, 2004).

This risk becomes significantly greater if eels are imported from the continent for stocking. Some diseases are ubiquitous and not easy to control such as the swim bladder parasite *Anguillacoides crassus* (Kennedy and Fitch, 2006). In these cases the emphasis should be on minimising the risk of spread.

6.1.2 Depleting source stock

Elvers or eels captured for transfer/on growing and stocking would eventually have reached their natural destination within that catchment. The stocking plan must have reasonable assurance that the removal of the stock will provide greater benefits in terms of silver eel output than if they had been left in situ.

Similarly, the design and operation of on-growing facilities need to ensure that survival bottlenecks can be overcome with minimal mortality – so that there is a net benefit from stocking.

6.1.3 Genetic considerations

Although some studies have claimed to show genetic differentiation between spatially separated European eel stocks (Maes and Volkaert, 2002) it is now generally accepted that the population is best explained as a panmixia (i.e. one large population) (Dannewitz *et al.*, 2005).

For this reason, moving fish to different catchments seems to present only a low threat to genetic integrity. However, as with all captive breeding programmes the need to maintain genetic diversity and reduce domestication remains paramount. At present, it is not possible to reproduce the life cycle of the European eel in aquaculture and eels must be grown on from captured elvers. The chances of in-breeding are therefore small.

Although the migration of leptocephali (larval stages) to coastal areas of Europe is known to be passive, the out-migration of silver eels requires an intensive effort to reach the spawning grounds in the (presumed) Sargasso sea. It is not known whether this process involves a degree of imprinting and, if so, at what stage in the life cycle this occurs.

Studies in the Baltic using “non-local” elvers have shown that some stocked elvers had difficulty in choosing the appropriate migration route (Westin, 2003).

6.1.4 Suitability of life stage for stocking location

Careful consideration should be given to the suitability of the habitat being stocked in terms of the timing of capture of eels and the life stage being used i.e. is it appropriate to translocate glass eels caught just off the estuary to the headwaters of a river system?

6.1.5 Ecological implications

It is possible that introduced eels could have a negative effect on local fish and invertebrate species. This will depend upon on the numbers of eels being stocked and on their life stages.

However Mann and Blackburn (1990) have demonstrated that eels do not compete with salmonids for invertebrate food sources and that salmonids do not form a major part of the eel diet.

When stocking designated rivers (i.e. SSSI/SAC rivers) with eel, consent would be required from Natural England or Countryside Council for Wales in addition to Environment Agency consent. It may also be necessary to carry out an appropriate environmental assessment. The local authorising officers will play a key role in informing decisions to stock and consulting with other stakeholders.

Eels are known to predate on crayfish therefore introductions should be considered very carefully where there are populations of native white clawed crayfish. Local Environment Agency officers will assess risk on a site by site basis.

6.1.6 Unpredictable supply

The supply of elvers for stocking may be difficult to predict. There is therefore a risk that long-term stocking projects may not be completed, particularly if they require scientific evaluation.

This means that it may not be possible to meet the long-term aims for silver eel escapement that are set out in an original stocking plan.

6.1.7 Increased illegal fishery

European Directives require that 60 % of all elver catches must be made available for re-stocking by 2013. In theory this could create a shortfall in supply for commercial aquaculture and make elver significantly more valuable. This may, in turn, encourage an increase in illegal fishing.

6.1.8 Recommendations

- Minimise disease risks by sourcing and stocking in the same catchment. If this is not practicable, use short-term holding in aquaculture facilities. This will allow screening for diseases.
- The stocking plan should consider the cost benefit of the methodology employed compared with leaving the elvers in situ or considering other options for restoration.
- On-growing facilities should only be considered if they are professionally staffed and operate to the strictest husbandry and biosecurity regimes which can confidently produce high survival rates.
- Sourcing and stocking eels in the same catchment will reduce the risk of compromising genetic integrity.

- The impact of stocking eels on other species, particularly native crayfish should be considered.
- The stocking plan should consider the uncertainty of supply which could mean that it may take longer to achieve eventual aims.

Appendix 1

Habitat Selection Criteria

Site name
Upstream National Grid Reference (NGR)
Downstream NGR
Life stage to be stocked

Criteria at basin scale

Water quality and sediment contamination
Water quality parameters meet those suitable for eel.

Connectivity to sea
Migrating silver eels have free access to the sea: consider physical and chemical barriers to downstream migration.

Entrainment risk
There are no water intakes that could prevent silver eel migration

Eel density
Current eel density is generally low.

Political, social, ecological risks
There are no social or ecological factors that make stocking inappropriate.

Criteria for prioritising sites

Habitat diversity and quality
Use the best information available. Consider the diversity and quality of physical habitat.
If information on the diversity and abundance of eel prey items is available, consider this in your assessment.

Longitudinal connectivity
Is there free passage throughout the river network ?

Lateral connectivity
Will eels have access to flood plains and off-channel habitats during high flows?

Lake habitat
Are there lakes with open access within the river network?

Eel fisheries
Basins with active sport/commercial fisheries are less likely to achieve the goals of stocking programmes.

Criteria for site selection

Low eel density
Local eel density should be below carrying capacity – in terms of number (< 2 eels/m^2) and biomass (<0.2 g/m^2).

Eel-free reaches
It is easy to monitor sites which lack eel because artificial barriers prevent upstream migration.

Experimental design and monitoring
Stocking schemes should incorporate experimental designs and monitoring programmes.

Partnership opportunities
Site has opportunity for partnerhip / financial contribution.

Appendix 2

Further research

The present guidelines on stocking of eels are based on our current knowledge and the application of the “precautionary principle”. However, It is recognised that there are many gaps in this knowledge base with regard to the biology and behaviour of the eel and to the evaluation of the effectiveness of stocking practices.

Research in the following areas would help to fill some of these gaps and ultimately lead to more informed management decisions:

1 Sex differentiation

- When is sex determined in nature?
- Can we develop non-lethal methods (such as DNA analysis) for detecting sex and at what life stage could these be used?
- What density in nature and in culture tends to produce a greater proportion of either males or females?

2 Stocking

Which stocking practices produce the best results, in terms of survival and contribution to future generations? We need to consider

- time of stocking;
- density;
- frequency;
- life stage;
- habitat yield (rivers/lakes);
- marking/tagging methods for monitoring (non-lethal screening);
- cost benefit.

3 Migration and imprinting

Do eels undergo imprinting in their initial migration phase? If so, does this affect their ability to home to their spawning grounds if translocated for stocking ?

Appendix 3

Stocking plan

<u>Guidance notes</u>

The form below should be completed by anyone proposing to carry out a programme of eel restocking. The completed form will enable you to give due consideration to your proposed stocking programme and ensure that it is properly planned and appraised.

Please read these notes carefully before filling in the form. They will help you to provide the required information. We recommend that you get advice from your local Environment Agency fisheries team before considering an elver translocation scheme.

The information submitted on this stocking form will be used by your local Environment Agency Fisheries team to assess whether the scheme adheres to Environment Agency policy on stocking elvers. It will also be used to assist Environment Agency consenting officers in determining any consent to introduce eels. Failure to provide the information may lead to consent being delayed or refused.

Please note that this form does not replace the need for:

an authorisation to use a fishing instrument (other than rod and line) to remove fish – use an FR2 form;

a consent to introduce fish – use an FR1form.

1 Background to scheme

Use this section to provide information on who is doing the scheme and why.

2 Current state of stock:

Please provide information such as monitoring data on the current state of the eel stock in the waterbody concerned.

3 Objective of stocking scheme:

Use this space to record what you hope the stocking scheme will achieve. Example objectives include:

To introduce elvers into a suitable habitat that is not being utilised by eel due to upstream barriers.

Scientific study.

4 Options appraisal:

Please provide evidence that other options have been considered. Explain why stocking is your preferred approach. You should also use this section to provide details of any other work you have undertaken, or are planning to carry out, in order to increase stocks. For example –the removal of barriers to migration.

A Information on the source of eels

Please provide as much information as possible on the supplier of the eels.

B Information on the on-growing or holding facility

If you are planning to grow on elvers for stocking at a larger size you will need to work with the on-growing facility to fill in this part of the form.

We require a copy of the bio-security plan for the site. This to ensure that the risk of disease transfer is adequately controlled.

C Translocation / stocking details

Please provide the target number and life stage of the eels you will be stocking.

We will also need to know where and when the eels will be stocked. Include a National Grid Reference and the dates.

Assess the stocking locations to ensure that there are adequate habitat and food sources to support the stocked eels.

Stock elver at appropriate densities, as calculated using the Cefas model. A summary of the model and other research references can be found in the Environment Agency guidance document “Stocking European Eels (*Anguilla anguilla*)”

Provide details of any monitoring programme, such as electric fishing surveys or trapping, that you will use to assess the stocking programme. It is desirable to carry out some monitoring, so that you can clearly demonstrate any benefits arising from the stocking scheme.

What to do next:

Submit your completed form to your local Environment Agency Fisheries team. They will then contact you to discuss your scheme. You will find a list of local Environment Agency offices at: www.environment-agency.gov.uk/

GLASS EEL / ELVER STOCKING PLAN PROFORMA	ENVIRONMENT AGENCY
1 Background to scheme	
Name of fishery/lake/river:	
Life stage (please circle): Glass eel / elver / eel	
Scheme applicant (name):	
Address:	
Telephone number:	
Name(s) of participating angling/conservation or other interests:	
What is the current state of the eel stock in the waterbody? Is the waterbody failing to meet its Eel Management Plan eel escapement target?	
Is the river/catchment a Site of Special Scientific Interest (SSSI) or a Special Area of Conservation(SAC)? Y/N	
Objective of stocking scheme Please use the space below to explain what the scheme will achieve. Continue on a separate sheet if necessary.	
Options appraisal Have you considered other options to increase eel stocks – such as habitat restoration or elver passes? Please explain why stocking is the preferred option. Continue on a separate sheet if necessary.	

Other stocking schemes Please give details below of any other relevant stocking schemes in the catchment. Continue on a separate sheet if necessary.
Duration of scheme (in years):

Start date for scheme:	End date:

2 Information on the source of eels
Source river / estuary:
Supplier's name and address:

Source location(s) and National Grid Reference	Date(s)

Collection method: Hand net / trap /fyke other (if other please give details):
3 On-growing or holding facility information
Name of facility:
Owner/Operator:
Address:
Cefas Fish Farm Registration number:
Catchment/ Watercourse:
Has a bio-security plan been produced for the fish farm? If yes, please provide a copy.
4 Stocking of progeny

Life stage:	Number :	Weight:
Elvers smaller than 12cm		
Juveniles Between 12cm and 20cm		
Eel Larger than 20cm		

Transport information Please provide information on how you plan to transport the eels safely to the stocking locations:

Proposed stocking locations	NGR	Date of stocking
1		

2		
3		
4		
5		
6		
Has an assessment been done at the proposed stocking locations of: water quality, habitat quality, habitat availability ? Yes/No If yes, please provide details in the box below.		
Please provide information on the suitability of the waterbody for stocking with eels. For example: the available habitat, food, and access to the sea.		
What monitoring is planned? Please provide details in box below.		
Please provide an assessment on how you expect stocking will affect the other species present :		

Appendix 4

Transport consignment note – for live eel and eels less than 12 cm

All fields marked with an asterisk (*) are mandatory.

<table>
<tr><td colspan="2">1. Name and address of transporter *

Telephone no.
Fax no.
Email address</td><td colspan="2">2. Name and address of animal's (eel's) owner *

Telephone no.
Fax no.
Email address</td></tr>
<tr><td colspan="4">3. Transport identification
Vehicle description   Vehicle registration</td></tr>
<tr><td colspan="2" rowspan="3">4. Description of goods (please circle appropriate entry) *

LIVE EELS LESS THAN 12 cm
LIVE YELLOW EELS
LIVE SILVER EELS

Count:</td><td>Country of export *</td><td>Net weight Kg *</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Total net weight Kg *</td></tr>
<tr><td colspan="4">5. Status (please circle appropriate entry) *
Restocking   Other (please specify)</td></tr>
</table>

6. Loading address/location of animals if different to section 1 or 2 *	7. Final destination address/location of animals *
8. Date of loading	9. Time first animal loaded
10. Date and time of departure *	11. Estimated duration of journey *
12. Date last animal unloaded	13. Time last animal unloaded
14. Source (River Basin District) *	

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List of abbreviations

AAHR – Aquatic Animal Health Regulations

Cefas – Centre for Environment, Fisheries and Aquaculture Sciences

Defra – Department for Environment, Food and Rural Affairs

EIFAC – European Inland Fisheries Advisory Committee

ICES – International Council for the Exploration of the Sea

WGEEL – ICES/EIFAC Working Group on Eels

GRP – Glass reinforced plastic

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