and nine years in the Severn RBD is therefore estimated to be 184,000, although variation in year-class strength may result in estimates ranging between 112,000 and 596,000. With the Severn RBD figure in mind, the predicted 273 shad equates to 0.15% of the population, which is the figure used by EDF in their report to inform the HRA. The Joint Nature Conservation Committee's (JNCC) species accounts for the twaite shad roughly estimate the UK population to be approximately 100,000 fish (best guess)[194], which is highly likely to be a conservative number and, therefore, represents worst case scenario. If the predicted number of individual twaite shad caught on HPC intake is calculated to be 273, then that accounts for 0.27% of the UK population. As this is highly precautionary and <1%, HPC alone is not likely to adversely affect the twaite shad populations of the Severn Estuary. To support this view, Environment Agency shad specialist Miran Aprahamian considered the predicted number of shad being caught on the intake screen (273 individuals) to be trivial and unlikely to impact on population numbers over the years (Miran Aprahamian personal observation)[195]. Further to this, because it is not currently possible to derive EAVs for twaite shad, the predicted total annual impingement of 273 shad is even less likely to impact on the overall shad population.

In most respects, the life cycle of the allis shad is very similar to that of its more common relative the twaite shad, except that the allis shad tends to be larger and migrate further upstream during their spawning migration (Bird, 2008). The River Severn has historically had breeding populations of allis shad, however, there are currently no known spawning populations of these species in the UK, which is why it was recently removed as having SAC status within the Severn Estuary. Even without mitigation in place, impingement impacts from HPC alone will not have an adverse effect on the allis shad.

Conclusion
We can conclude that the abstraction at HPC alone will not have an adverse effect on either the twaite shad or allis shad populations designated under the Severn Estuary SAC and Ramsar as a result of impingement.

Lamprey (*Petromyzon marinus, lampetra fluviatilis*) - impingement
Two anadromous species of lampreys use the Severn Estuary as a migratory corridor, the sea lamprey (*Petromyzon marinus*) and the river lamprey or lampern (*Lampetra fluviatilis*). The River Severn has always been an important river for both species and despite the extensive construction of weirs in the 19th century, it probably still supports the greatest number of sea and river lampreys of any northern European river (Bird 2008).

Like shad, the favourable condition status for lamprey in the Severn Estuary has not yet been described under Regulation 35(3)(a) (formally Regulation 33(2)(a)) by the conservation agencies, but again it is thought that both lamprey populations are in unfavourable condition. The most recent condition assessment for the Wye and the Usk in 2007 classified the River Usk as unfavourable for river lamprey and the River Wye as unfavourable for sea lamprey.

To estimate the lamprey population within the Severn Estuary, Technical Report 148 again uses the Severn Tidal Power Feasibility Study Strategic Environmental

[194] Second Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2001 to December 2006 Conservation status assessment for : S1103: *Alosa fallax* - twaite shad. http://www.jncc.gov.uk/article17
[195] Advice sought from Miran Aprahamian 17 October 2011, via telephone conversation.

Assessment that recently attempted to estimate lamprey population size and age distributions (APEM 2010) using measurements of life history traits collated from the literature to construct a generic life table for sea lamprey and river lamprey. Lampreys were assumed to represent one discrete population, given the species' capacity to disperse as evidenced by their lack of homing and wide juvenile movement within several rivers throughout the UK. The life cycle of lamprey was represented by a stage structured model and constructed with vital rate data and information on: average age at metamorphosis (ammocoete and parasitic juvenile); average ammocoete density per m² of optimal and suboptimal habitat; metamorphosis success (ammocoete to parasitic juvenile); ammocoete survival; and sex ratio.

Markov Chain Monte Carlo (MCMC) simulations were used to estimate the mean population size from the model output and provide a likely average population size of adult lamprey in the Rivers Usk and Wye. These estimates have been based on best guesses of available habitat of 1% per metre length of river for both optimal and suboptimal habitat. The population estimates for sea lamprey are 15,269 and for river lamprey 116,109 (APEM, 2010). Although the River Severn is known to support large populations of both river and sea lamprey, no other data on lamprey populations in and around the Severn Estuary exists. Therefore, population estimates of both the Wye and Usk appear to make a useful conservative approximation that can be used as a worst-case scenario for the Severn Estuary. Taking the above figures into account, the numbers of lamprey likely to be affected by the abstraction process equate to 0.014% of the river lamprey population and 0.27% of the sea lamprey population. As both figures calculate that <1% of each population will be potentially affected as a worst-case scenario, impacts are not considered to be significant.

Conclusion
On this bases of the above impingement calculations, we can conclude that the abstraction at HPC alone will not have an adverse effect on either the river or sea lamprey populations designated under the Severn Estuary SAC and Ramsar as a result of impingement.

Eel (*Anguilla anguilla*) - impingement
The Severn Estuary and its rivers constitute the largest eel fishery in the UK; constituting 95% of all glass eels (juveniles migrating towards freshwater) caught in England and Wales. The River Parrett supports the second most productive elver fishery in England (Langston et al. 2003)[196]. However a recent completion of a 30-year study of the estuarine population of yellow eel (*Anguilla anguilla)* abundance in Bridgwater Bay showed that the population number has collapsed since 1980 at an average decline of 15% per year (Henderson, 2011)[197]. The abundance of eel in 2009 is estimated at only 1% of that in 1980 and the reasons for the decline are unknown.

The European eel is listed as critically endangered on the IUCN red list for threatened species. In March 2009, the European eel was also added to the Convention on International Trade of Endangered Species (CITES) Appendix II list to control trade.

[196] Langston, W. J., Chesman, B. S., Burt, G. R., Hawkins, S. J., Readman, J., & Worsfold, P. (2003) Characterisation of the South West European Marine Sites: The Severn Estuary pSAC, SPA. pp. 206. Marine Biological Association Occasional publication No.13.
[197] Henderson, P.A., Plenty, S.J., Newton, L, C., Bird, D.J. (2011). Evidence for a population collapse of European eel (*Anguilla anguilla*) in the Bristol Channel. Journal of Marine Biology.