1. Bristol Channel Hinkley Nuclear Power Station

1.1. Overview

State area of sea in relation to coastline, 12nm and continental shelf, estuaries etc

Hinkley Point nuclear power station sits within the Bridgwater Bay ecosystem, at the interface between the inner Bristol Channel and the outer Severn Estuary, ~10km southwest of Bridgwater.

State industry this case study focuses on

Hinkley Point (HP) is comprised of three sites:

- HPA was developed in the early 1960s, operated until 2000, now being decommissioned
- HPB was developed in the early 1970s, has been generating since 1976 to the present date; it is estimated that decommissioning will start on this reactor at some point in 2016.
- HPC is a proposed development for two new nuclear reactors currently being undertaken by EDF Energy, next to HPA and HPB.

The monitoring assessment addressed in this case study relates to the EIA for HPC, which has been informed by earlier monitoring efforts at HPB.

1.1.1. Generic Current Status of Industry Sector

History and forecast (where known) of requirements to conform to legislation in environmental monitoring

Currently there are six nuclear sites operating in England (and three closed sites). All of these are operated by EDF Energy with the exception of Oldbury. The British government is currently attempting to diversify its energy mix and identified eight sites in 2009 for future reactors in England (2009), with an aim to bring them into operation by 2025. These eight power plants have since been reduced to five (2010), all of which are at existing sites.

The principal regulators involved in this sector include the Office for Nuclear Regulation, which authorises operations with Nuclear Site License and enforces by inspection and review; and the Environment Agency which authorises solid, liquid and aerial discharges (framework of licenses). Other regulators include the Office for Civil Nuclear Security, Department of Transport and Local Authorities.

1.1.2. Overview of Case Study Industry Activities

Characteristics of main industry in case study including status of development and development round

Within the Bristol Channel and Severn Estuary there are also marine aggregate license areas Culver Sands (/extension), Holm sands and North Bristol Deep. Further west is the Round 3 offshore wind farm development, Atlantic Array, in early stages of planning. It is also an important area for commercial

fishing. In addition, it contains an important commercial shipping route for access to Bridgwater, Cardiff, Barry, Avonmouth and Newport; and is a popular location for recreation with several marinas and yacht clubs including two in close proximity to the proposed Hinkley development.

Emphasis on particular biological (and biophysical) parameters and reason for this

Hinkley Point nuclear site has required monitoring of marine biological habitats and species primarily to assess the impact of the temporary jetty, discharge / intake and dredging. These affect the local fish assemblage and intertidal habitats, as well as displacement of important bird species, loss of potentially important habitats and feeding grounds. Also of significance are the assessments of water quality and the `sediment budget`.

Specific local / national drivers for monitoring

HPC requires a number of consents and licenses including: a license under FEPA; consent from West Somerset Council (WSC) under the Town & Country Planning Act 1990 (TCPA); consents from the Marine Management Organisation (MMO) such as the Harbour Empowerment Order (HEO) and for marine structures (temporary jetty and outfall/intake) (EDF Energy, 2011[1]).
The development of HPC and the associated structures are subject to EIA in accordance with the requirements of the EIA Directive (85/337/EEC, as amended), this Directive is transposed into national law by the:

- Harbour Works (EIA) Regulations 1999; and
- Marine Works (EIA) Regulations 2007.

This involves collaborative working in the intertidal, subtidal and terrestrial elements of the site with a number of land owners in the surrounding area including the Crown Estate, and Somerset County Council (EDF Energy, 2010[2]), as well as dealing with cross-border issues in monitoring. The site has also required a Habitats Regulation Assessment due to the perceived impact on a number of international important conservation designations (Natura 2000 sites).

The Bristol Channel / Severn Estuary are used by a large number of stakeholders and consultations of developments at Hinkley Point require consultation with several interest groups, e.g. Severn Estuary Partnership, Severn Estuary European Marine Scheme, Severn Estuary Coastal Group, Severn Estuary Shoreline Management Plan Group and the Association of Severn Estuary Relevant Authorities (ASERA). Some of these undertake their own monitoring of important sites.

Natural England is a member of the ASERA Management Group (other SNCAs are the IFCA, EA, CCW). ASERA set up the Severn Estuary European Marine Scheme in 2004. This scheme considers members'

[1] EDF Energy 2011. Hinkley Point C, Environmental Statement Non-Technical Summary.
[2] EDF Energy, 2010. Hinkley Point C, Proposed Nuclear Development: Environmental Impact Assessment Scoping Report.

activities and any potential impact on SAC / SPA features. The aim is for SNCAs to decide what regulation is needed to prevent damage to the site. This is also aimed towards fulfilling the requirements of the Habitats regulations.

1.1.3. Overview of Case Study MPA Designations

The principal sites close to HPB and focused on in assessment of this site include the Severn Estuary SAC (designated 2009), SPA (1995) and Ramsar (1995) sites. It is only the marine aspects of HPC that is contained within these designated areas (not the development site itself)[3].

Also within the area (within a 20km buffer, as used in the Habitat Regulation Assessment) are: Exmoor and Quantocks Oakwoods SAC, Hestercombe House SAC, Mendip limestone Grassland SAC, River Usk SAC, River Wye SAC, Somerset Levels and Moors SPA, Somerset Levels and Moors Ramsar. Additionally the site is considered an Area of Outstanding Natural Beauty and a Site of Community Importance.

The Severn Estuary is designated as a SPA to protect the many migratory, overwintering and waterfowl bird species, such as the Bewick`s Swan (*Cygnus columbianus bewickii)*. The SAC is protected for Annex I features including: estuaries, subtidal sandbanks, intertidal mud and sand, Atlantic salt meadow/salt marshes and biogenic reefs (*Sabellaria*). Annex II features include migratory fish species of river/sea lamprey and twaite shad. These species along with salmon, eel, sea trout and allis shad are also designated features of the Ramsar Site. Qualifying features in the Ramsar site overlap those of the SAC and SPA.

1.2. Industry Monitoring Programme

1.2.1. Survey Characteristics

Development of monitoring through different stages of sector development

The British Energy Estuarine and Marine Studies (BEEMS) programme has been set up by EFD Energy for Cefas to implement a multi-disciplinary programme of marine studies (principally monitoring) to support new-build power stations in the UK. This is coordinated with other scientific institutions and through some sub-contract of specialist work. The BEEMS work is carried out prior to the EIA process to inform complete scientific evidence with no further monitoring carried out at the EIA stage.

BEEMS has undertaken a significant volume of monitoring work at Hinkley Point B. The aim of these surveys was to characterise the habitats surrounding Hinkley Point and to identify impacts on the environment prior to the EIA (results of some of these surveys have now been transposed for the HPC EIA).

For example, impacts of the discharged cooling waters from Hinkley Point B on the local populations and species richness of fish in the Severn Estuary have been monitored at Hinkley since 1981. Commissioned originally by British Energy (now EDF Energy) the monitoring scheme now forms part of the Severn

[3] Severn Estuary SAC, SPA and Ramsar Site: Regulations 33 Advice from CCW and Natural England, June 2009.

Estuary Dataset (SEDS), (monitoring and database by Pisces Conservation Ltd, pers. comms. EFD Collin Taylor). Monthly samples help identify any impacts of changes in water temperature and salinity on fish populations.

Environmental monitoring at HPC will be a continuous process over the life time and decommissioning phase of the power plant. Under the Ecological Management and Monitoring Plan (EcMMP) attached to the environmental statement for the development, it stipulates that periodic auditing and inspections will be carried out and/or arranged by EDF Energy appointed specialists. This systematic monitoring is an attempt to ensure the mitigation measures or specific protected species license conditions are being met.

Biological (and biophysical) features monitored

The main attributes and features monitored as part of the surveys have included:

- **subtidal benthic infauna**. Initial offshore and nearshore (subtidal) biological surveys have been carried out quarterly since February 2008 (June, August and November 2008) then annually for May 2009 and June 2010. Coverage was of broad area extending up to 15km from HPC (estimated area of impact of thermal plume) with 18 stations sampled using a day grab (16 additional stations chosen for June 2010 survey to extend coverage)[4]

- **intertidal fauna**. Intertidal habitat surveys were carried out July 2008 with 40 stations in the Bridgwater Bay area; July 2010, with 21 of the original stations plus 13 new stations; January 2011 (Hinkley point to Watchet) and Febuaray 2011. This included 55 sites, from the intertidal mud and sandflats up to about 8 km north of the River Parrett estuary, to the shoreline 15 km west of Hinkley Point. There were 40 soft sediment, 12 rocky shore, 3 saltmarsh sites. The locations of these stations was largely based on historic data, with the most influential being the Phase 1 biotope mapping survey conducted during 2002 -2004 by EMU ltd, originally commissioned by Natural England[5].

- **ornithology**. Intertidal bird surveys were undertaken along the River Parrett between April 2009 and March 2010 as part of the monitoring requirement to extend the Combwich Wharf. This comprised of 48 intertidal bird surveys from five observation points. The surveys were divided into a 5 areas of 200m^2 grid cells, with observations conducted over a 6 hour period[6]

- **subtidal benthic epifauna**. As for benthic fauna temporal and spatial extent. 18 stations were sampled using the 2m beam trawl

- **benthic fish**

- **fish egg and larval abundance**

[4] Cefas, 2010. TR136a HP Benthic Grab Comparison.
[5] Cefas, 2011. BEEMS Hinkley Intertidal Post Survey Report.
[6] EDF Energy, 2011. Combwich Wharf and Laydown Facility Baseline Bird Report.

- **zooplankton and phytoplankton**. During the grab / trawls, 25 plankton stations were sampled based on a spatial grid design
- **impingement and entrainment**

Table 1, showing the generic monitoring requirements of the Severn Estuary SPA, SAC, Ramsar and Bridgwater Bay SSSI

Activity and/or effect	Designated feature potentially affected	Monitoring requirement
Severn Estuary SAC		
Loss/alteration of foreshore and subtidal habitat	Estuaries; Intertidal mudflats and sandflats	Location and extent (in m^2) of any habitat loss/change from within the intertidal and subtidal areas of the SAC. Composition of marine communities within areas where habitat loss is predicted. Emphasis placed on the presence/absence of Sabellaria. Calculations of likely loss for those affected habitats that form part of the designated interest feature Investigating any loss with regards to ecological functions of the designated habitat features e.g. recruitment capacity.
Water quality during construction	Estuaries; Intertidal mudflats and sandflats Reefs; Annex II fish populations	Predicting release of sediments into the water column during construction of aggregates jetty, intake/outfall structures and dredging of berths. Potential venerability of intertidal and subtidal marine communities to contaminants in discharges. Information on protected fish species, found within discharge areas, specifically on migratory behaviour and general ecology, estimate of population size and trends.
Water quality during operation	Estuaries; Intertidal mudflats and sandflats Reefs; Annex II fish populations	Information on the discharges during operation (thermal plume effect on intertidal/subtidal areas). Predicted alterations of the chemical and thermal conditions within the Estuary resulting from the discharge.
Disturbance to designated fish species during construction resulting from underwater noise	Annex II fish species	Data on potential noise generating activities including noise levels, duration, timing and location. Sensitivity of designated fish species to noise levels
Potential to disturb migratory fish species during breeding, feeding and resting locations	Annex II fish species	Description of locations of marine structures that may inhibit migratory fish species

		Marine structure influence on hydrodynamics and sediment transport. levels of increased light levels in the water column and behavioural responses of fish species to light level changes
Impingement and entrainment of designated SAC fish species	Annex II fish species	Assess the impact of cooling water system on fish mortality compared to typical mortality for SAC species.
Severn Estuary SPA		
Disturbance to waterbirds using the foreshore and adjacent cliff-top fields during construction	SPA designated bird populations	Total bird numbers using foreshore and fields – peak numbers and mean peaks from counts undertaken. Presence of SPA designated species and areas these species occur. Sensitivity of SPA species to activities likely to cause disturbance (e.g. construction noise levels, human activity) Establishing the availability of suitable habitats in close proximity that SPA species may inhabit during construction.
Disturbance and displacement of waterbirds during operation phase	SPA designated bird populations	Sensitivity of SPA species to operational activities (operational background noise levels, lighting) Lighting design of temporary jetty and power station buildings. Availability of alternative habitats
Loss of habitat and impact on bird usage	SPA designated bird populations and the habitats that support them	Area of habitat lost (m^2) (Marine/Terrestrial) Use of affected area by SPA species and ecological (Food) requirement of this species. Changes to drainage system of terrestrial sites and impacts upon downstream hydrology.
Changes to water quality during construction and operation and implications on habitats used by SPA species	SPA designated bird populations and the habitats that support them	The same monitoring requirements as water quality in SACs Extent of impacts upon areas of important habitat from the cooling water thermal plume (Contaminates, reduction in food resource)
Potential for localised changes in air quality		Considerations of the changes of air quality during the construction and operational phases. May include statement regarding radiological emissions

		to air and the associated risk.
Severn Estuary Ramsar Site		
Issues largely covered under SPA and SAC notes above. However there are a number of difference		Marine habitat feature are confined to intertidal and terrestrial areas (no subtidal) Fish assemblage covered by the Ramsar designation, includes: • River and sea lampreys, twaite and allis shad; and • Salmon, sea trout and common eel.
Bridgwater Bay SSSI		
Loss of Habitat	Salt marsh, Estuary	Potential negative effects of dredged material being disposed of outside of the estuary, tampering with sediment budget. Monitoring of the negative effects of the increased vessel activity at the Combwich Wharf facility (vessel speed and frequency)
Majority of issues covered in the previous sections above		Monitoring of water quality (Thermal plume), loss of habitats due to construction of marine infrastructure, ecological function of habitats, populations of important waterfowl species.[7]

[7] Chapter 19, Marine Ecology. Hinkley Point C Pre-Application Consultation – Stage 2. Environmental Appraisal.

1.2.2. Monitoring methods

Monitoring protocols and survey methods

- ***Corallina* and Rocky Shore**. 1 m Quadrat subdivided into 33 x 33 cm squares (Intertidal); mid and low shore surveyed; random placing of 1m quadrat; 5 replicates
- **Intertidal Invertebrates**. 0.01 m^2 corer, 15cm depth, 5 replicates
- **Epifaunal abundances/diversity**. 1m epibenthic sled, 5mm mesh, towed at $1ms^{-1}$ or less for 5 minutes – deployed during spring, summer and autumn months, replicating stations from initial spring (April) survey.
- **Intertidal Epifauna**. Baited epifaunal traps; single cage with 3 baited epifaunal traps left for 4 hours
- **Intertidal fish species** – Fyke nets (Height 50cm, Mesh Size 6.5mm and a leader of 14ft) and Seine netting[8]
- **Subtidal Infauna.** Predominantly 0.1 m^2 Day grab with 4 replicate samples; but 7 of the 18 stations used a Hamon grab used alongside the Day grab – 3 replicates; Anchor dredge deployed in areas Hamon grab failed to retrieve samples[9]
- **Subtidal epifauna and benthic fish.** 2 m beam trawl
- **Plankton.** 500 µm mesh plankton net
- **Fish egg and larval abundance**. Gulf VII high speed plankton net, 25 Stations[10]
- **Bird food and bird disturbance surveys** [11]

1.2.3. Post Survey Data Processing

Type of processing and data products derived, including level of detail provided. Provide detail for different parameters as relevant.

Day grab samples were sieved down to 1mm, large or fragile samples were picked off the 5mm sieve to minimise damage. Methods followed the published guidelines for the conduct of benthic surveys, used by the aggregate industry for monitoring purposes[12].

Intertidal surveys incorporated Particle Size Analysis (PSA) and Organic Content (OC) Anaylsis, using a 0.01 m^2 corer to collect 5 replicate sediment samples at depths of 5cm.

[8] Cefas, 2011. BEEMS Hinkley Intertidal Post Survey Report.
[9] Cefas, 2010. TR136a HP Benthic Grab Comparison.
[10] EDF Energy, 2011. Volume 2 Hinkley Point C – Chapter 19 Marine Ecology.
[11] Chapter 19, Marine Ecology. Hinkley Point C Pre-Application Consultation – Stage 2. Environmental Appraisal.
[12] Cefas, 2010. TR067 HP Nearshore Communities Ed 2 BPE.

Difficult to identify fish species were returned to laboratories to identify to species level where possible using standard identification guides (Maitland & Herdson, 2009; Wheeler, 1969).

Identification of epifaunal samples was carried out to the lowest possible taxon (i.e. species), using standard taxonomic keys (e.g. Hayward & Ryland, 1990; Smaldon, 1993). Blotted wet weight of each individual species in each sample was measured, following standard NMBAQC methodology.

Metadata completed and standards used, whether internal / external and if required by regulations or completed anyhow. Provide detail for different parameters as relevant.

Complete survey logs were maintained at each station on the intertidal and offshore BEEMS surveys, detailing information on the time, position, climatic conditions, and physical characteristics of the sediment and nature of the bed. GPS data loggers were also used on these surveys which directly linked to the Cefas Fishing Survey System database electronically recording the station data during all surveys[13].

Quality assurance carried out whether internal / external and if required by regulations or completed anyhow (and confidence of data). Provide detail for different parameters as relevant.

Quality assurance methods are outlined below:

- BEEMS Surveys procedures SOP
- Cefas quality assurance procedure employed in taxonomic identification of epifaunal samples, with 10% of samples re-picked and identified by senior taxonomists
- ICES taxonomic QA procedure followed for intertidal samples
- Laboratories working in the fields of taxonomy, water quality and microbiology should be accredited by the following bodies UKAS, BSI and NMBAQC.
- Internal quality control procedures should also be in place in all subcontracted consultancy
- Regulatory guidelines should be followed such as those in the JNCC Common Standards Monitoring Handbook (JNCC 2004[14]).
- All faunal samples are archived for a period of a 1 year from the submissions of the data to the client or until confirmation from the client that there is no reason to retain the sample[15].
- Reference specimens of difficult or obscure epifaunal species present at Hinkley Point over the course of the sampling series were retained in the Cefas internal reference collection.
- Plankton samples are kept for a minimum of five years[16].

1.2.4. Dissemination of Data Products

Ultimate owner of data and any restrictions in place

[13] Cefas, 2010. TR067 HP Nearshore Communities Ed 2 BPE.
[14] JNCC 2004. Common Standards Monitoring Guidelines. JNCC ISSN 1743-8160.
[15] Cefas, 2010. TR067 HP Nearshore Communities Ed 2 BPE.
[16] Cefas, 2010. TR083 HP Nearshore fish & epifauna communities Ed3 text BPE.

Data from monitoring at Hinkley has been integrated into the Severn Estuary Dataset (SEDS). This is a stand along database operated by PICES Ltd, contractor to EDF.

Data is made available to the BEEMS Oracle data centre held by BEEMS.

EDF Energy is the owner of all the survey data they have commissioned as part of the monitoring requirements of their current operations and statutory requirements for new developments.

1.2.5. Internal Survey Management

Health and safety and risk management policies / approach

Each sub-contracted consultancy manage their own Health and safety procedures and policies, adhered to during each survey period and accompanying laboratory work.

Prior to the commencement of surveys, sub contracted consultancies ensured all survey personnel undertook a Health and Safety onsite induction at Hinkley Point Power station facility.

Disclosure of survey plans and timing / reason

The majority of survey plans and details are available as appendices of the ES or as separate technical reports. There is no sign of the disclosure of survey plans prior to any surveys.

Funds available for programme, source and flow of money

Surveys funding sourced through EDF Energy.

1.2.6. "Downwards" Contractual Set Up

Number of tiers sub-contracted survey operation, organisations involved and management / level of interaction or involvement by client

The BEEMS programme was managed by Cefas who co-ordinated the surveys, working on a sub-contract basis to a number of specialist consultancies: Amec, APEM, Titan, MESL, ABP mer, Jacobs, Hull University (IECS), HR Wallingford and Pisces Conservation Ltd.

1.3. MPA Monitoring Characteristics

1.3.1. Survey Characteristics

At a broad scale MPA monitoring within the Severn Estuary operates on a 6 year monitoring regime, where every attribute or designated feature of a site should be monitored once, against JNCC CSM guidance, within that 6 year period.

One of the last substantive monitoring schemes commissioned by Natural England on the Severn was a Phase One Intertidal Biotope Mapping carried out in 2006.

Further guidance on the levels of MPA monitoring found in the Severn Estuary were requested through numerous correspondences with Natural England, but was unfortunately not received before the submission deadline of the report, and therefore not included in the report.