9 CONSIDERATION OF THE EFFECTS OF LICENSING THE SEA 6 AREA

9.1 Introduction

The overall process adopted for this Strategic Environmental Assessment is described in Section 2. The approach and methods used to identify the potential effects that could follow from implementation of the draft plan to hold a 24th Round of offshore oil and gas licensing, and to assess their significance are outlined below. The base case for the assessment was Alternative 2 in Section 4.2 (i.e. to offer the area for licensing) since this was judged to represent the greatest scale of potential interactions and effects.

9.2 Approach

The assessment for this SEA was a staged process which has incorporated inputs from a variety of sources (outlined below) and shown in Figure 9.1.

Figure 9.1 – SEA 6 assessment process

The initial stage was the identification of interactions between the potential activities following licensing of the SEA 6 area and receptors within the environment (both the natural environment and human uses of the area). The interactions and implications considered include positive, negative, direct, indirect, cumulative, synergistic and transboundary effects. This initial step drew on input from scoping, published descriptions of the effects of oil and gas activities, previous DTI SEAs and the EU SEA Directive.

The next stage was to review the potential interactions to identify those which might potentially have effects of a scale which should be considered further in the SEA. This was achieved through an assessment workshop held in April 2005 (see Appendix 2). Workshop participants included authors of supporting technical documents, representatives of main regulatory agencies and the SEA steering group. The process followed is illustrated in the upper part of Figure 9.1 which includes the input information and outputs. Prior to the workshop, a pack of background information was circulated.

The interactions were reviewed at the workshop building on the experience from previous SEA assessment workshops. Expert judgement was used to identify those interactions which should be considered further in the SEA – see Appendix 2. The consideration included the scale, severity and duration of effects on the environment, human health and socio-economics, together with issues of public concern and took into account the criteria for determining the likely significance of effects included as Annex 2 to the SEA Directive. In this way the review attempted to ensure balanced consideration of scientific and perception issues.

The outcome of the assessment workshop were presented and discussed at a stakeholder dialogue meeting held in Manchester in August 2005 – see Appendix 3.

The final stage was detailed consideration of the interactions agreed at the workshop and the input from the stakeholder meeting. This stage is documented in the following Sections and included quantification of the scale and magnitude of the potential activities and interactions, consideration of the sensitivity and ability to recover of the receptor(s), existing controls and agreements in place (see Section 3.3), information gaps, and a conclusion regarding the potential effect of further licensing in the SEA 6 area.

Issues considered to be of negligible or minor importance in terms of a Strategic Assessment are not considered further.

9.3 Consideration of effects

Potential sources of effects from the activities which may result from implementation of the draft plan have been considered in terms of the likely significant effects on the environment, including on issues such as biodiversity, population, human health, fauna, flora, soil, water, air, climatic factors, material assets, cultural heritage including architectural and archaeological heritage, landscape and the interrelationship between the factors – see cross referenced summaries below.

Issue	Potential sources of significant effect	See Section
Biodiversity	Physical damage to biotopes, associated with pipeline construction	9.5
	Marine discharges – potential effects of non-native species introductions in ballast water discharges	9.7
	Major oil spill effects and associated damage to habitats and ecosystem function	9.10
Population	Interactions with other users – principally associated with commercial implications of exclusion of fishing activities in vicinity of infrastructure, and safety risks of interactions between fishing gear and subsea infrastructure.	9.6
	Other interactions with shipping, military and other human uses of the offshore environment (excluding fishing)	9.6
	Socio-economic consequences of oil spills	9.10
	Positive socio-economic effects of potential activities, in terms of employment, expenditure and tax revenue	9.11
Human health	Potential for effects on human health associated with - effects on local air quality resulting from atmospheric emissions - discharges of naturally occurring radioactive material in produced water”	 9.8 9.7
	Potential food chain effects of major oil spills	9.10
Fauna **zooplankton** **benthos** **cephalopods** **fish** **marine reptiles** **birds** **marine mammals**	Underwater noise - potential behavioural and physiological effects on marine mammals and fish associated with seismic surveys	9.4
	Physical damage to biotopes – potential effects on benthos, associated with anchoring and infrastructure construction	9.5
	Physical presence of infrastructure and support activities may cause behavioural disturbance to fish, birds and marine mammals	9.6
	Marine discharges – potential effects of	9.7

Issue	Potential sources of significant effect	See Section
	produced water discharges on zooplankton and fish; drilling wastes effects on benthos	
	Oil spills – risks of effects on all faunal groups	9.10
Flora phytoplankton macroalgae seagrass	Marine discharges – potential effects of non-native phytoplankton species introductions in ballast water discharges	9.7
	Oil spills – risks of effects of beached oil on intertidal algal and macrophyte populations	9.10
Soils and geology	Physical effects of anchoring and infrastructure construction on seabed sediments and geomorphological features	9.5
	Marine discharges – sediment modification and contamination by particulate discharges	9.7
	Effects of reinjection of produced water and cuttings	9.9
	Onshore disposal of returned wastes – requirement for landfill	9.9
	Oil spills (with or without chemical dispersion) – risk of sediment contamination	9.10
Water	Marine discharges – contamination by soluble and dispersed discharges	9.7
	Oil spills (with or without chemical dispersion) – risk of contamination of the water column by dissolved and dispersed hydrocarbons	9.10
Air	Local air quality effects resulting from exhaust emissions, flaring and venting	9.8
	Emissions of acid gases	9.8
	Air quality effects of a major gas release or volatile oil spill	9.10
Climatic factors	Contributions to greenhouse gas emissions	9.8
	Greenhouse gas emissions associated with combustion of hydrocarbons produced as a result of proposed activities, are outside scope of assessment	9.8

Issue	Potential sources of significant effect	See Section
Material assets	None	
Cultural heritage, including architectural and archaeological heritage	Potential effects in relation to known or postulated archaeological heritage	9.5
Landscape	Potential visual impacts of nearshore exploration and development including seascape effects	9.6
The inter-relationship between the issues	Multiple effects – biodiversity and faunal effects associated with habitat disturbance; contamination of water, sediment and fauna; oil spill risks	9.5, 9.7, 9.10, 9.12
	Conflicts between issues and receptors – reinjection vs marine discharges; and options for oil spill contingency	9.7, 9.9, 9.10, 9.12, 9.13

9.4 Noise

Previous SEAs have considered the potential for acoustic disturbance by noise generated by exploration and production activities. The range over which noise propagates (and effects may result) varies with water depth, density stratification of the water column, substrate and other factors and is therefore in part, area-specific. The sensitivity of species such as marine mammals may be influenced by previous exposure (i.e. sensitisation / habituation) and by the level of background ambient noise in the area.

The following assessment of potential acoustic disturbance in the SEA 6 area considers in turn:

- Ambient noise
- Noise associated with seismic surveys and other oil & gas activities
- Sources and propagation of noise in relation to predicted activity scenarios
- Sensitivities to acoustic disturbance
- Control and mitigation of acoustic disturbance
- Summary of potential effects

9.4.1 Ambient noise

Although the technical definition of ambient noise is that sound received which is not from the sensor itself, the more generic definition is the residual noise when identifiable individual sources are removed. Ambient noise in the SEA 6 area was reviewed by Harland *et al.* (2005) to support this assessment. The wide range of ambient noise sources include natural physical sources (e.g. wind, precipitation, sediment transport and shore/surf noise); biological noise (e.g. fish and crustacean species) and anthropogenic sources such as commercial shipping, aggregate extraction, industrial sources, military sources, fishing, recreation and aircraft.

Ambient noise has three constituent types – wideband continuous noise, tonals and impulsive noise. The latter is transient and is usually of wide bandwidth and short duration. It is best characterised by quoting the peak amplitude and repetition rate. Continuous wideband noise is normally characterised as a spectrum level, which is the level in a 1 Hz bandwidth. This level is usually given as intensity in decibels (dB) relative to a reference level of 1 micro Pascal (µPa). Tonals are very narrowband signals and are usually characterised as amplitude in dB re 1µPa and frequency. Ambient noise covers the whole acoustic spectrum from below 1 Hz, to well over 100 kHz. Above this frequency the ambient noise level drops below thermal noise (i.e. from Brownian motion molecular interactions).

In deep water the levels of ambient noise are now well defined and the contributions from various sources well understood and categorised according to dominant source and frequency (Urick 1983). Because of the comparatively shallow water in the SEA 6 area which will not support propagation at the lowest frequencies, ambient noise would be predicted to be dominated by distant shipping and sea surface noise originating close to the point of measurement.

In addition to the variety of ambient noise sources and characteristics, there are additional effects which will modify the level and spectral content of the ambient sound field. The effects of density variations on acoustic propagation, losses at the seabed and water surface and multi-path effects are discussed by Harland *et al*. (2005).

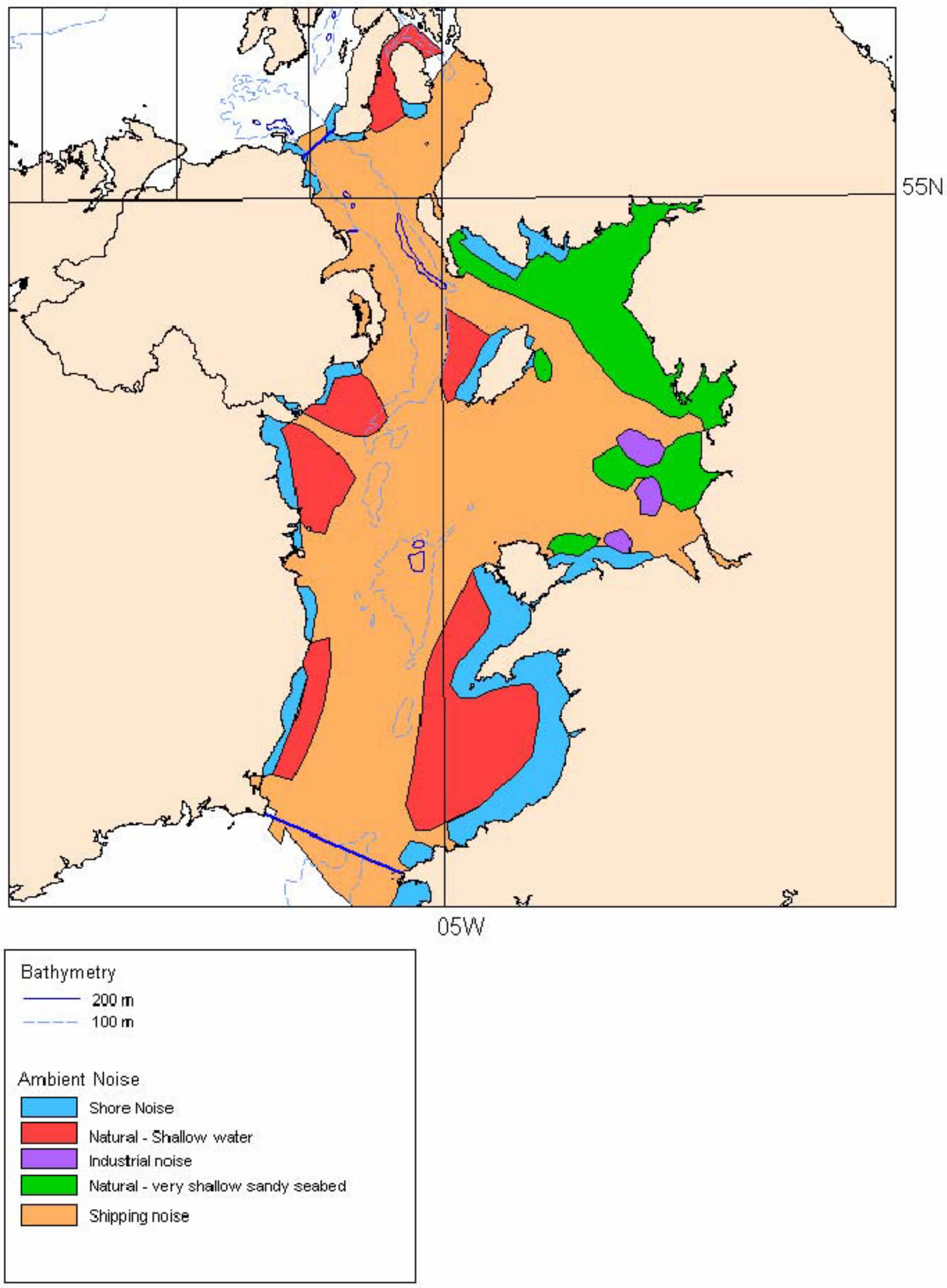
The most likely dominant noise sources across the SEA 6 area were mapped by Harland *et al*. (2005), based on the information gleaned during this study, from the experience of the authors studying the various sources of ambient noise over many years of sonar trials in the SEA 6 area and elsewhere. Figure 9.2 represents the situation at low wind speeds and no precipitation noise. Shipping noise is likely to dominate across large parts of the SEA 6 area. The shoreline is likely to be dominated by surf noise although for large areas of the eastern Irish Sea the angle of shelving is so shallow that, except at extreme low and high tide, there is no distinguishable shoreline, so in these areas wind/precipitation/sediment transport noise will dominate. The area offshore of Liverpool is likely to be dominated by industrial noise from shipping, oil and gas production facilities and wind farms.

Ambient noise models have been used by the military for some years as part of more complex models investigating the performance of active and passive sonars. This has led to the development of a number of ambient noise models, each with their own strengths and weaknesses. Preliminary illustrative outputs from the QUEST model has been used to predict ambient noise maps for the SEA 6 area including shipping lanes through to Liverpool from the north and south of Ireland, gas platforms in Morecambe Bay and the Holyhead to Dublin Ferry route for January, April, July and October respectively (Figure 9.3). It should be emphasised that these figures are illustrative rather than providing accurate data. The sound field shapes at the extreme north and south are distorted by modelling artefacts. The effect of shipping noise is very dependant on the time of year and the depth of the sensor, be it a hydrophone or marine organism. The variation in this example is caused by variations in the temperature stratification of the water column.

9.4.2 Noise associated with E&P

The sources of noise associated with exploration and production have been discussed, in terms of source characteristics, in previous SEAs 1-5 and supporting studies (e.g. Hammond *et al*. 2003, 2004). With the exception of explosives, airgun arrays used for seismic surveys are the highest energy man made sound sources in the sea; broadband source levels of 248-259 dB re 1μPa are typical of large arrays (Richardson *et al*. 1995). Airgun noise is impulsive (i.e. non-continuous), with a typical duty cycle of 0.3% and slow rise time (in comparison to explosive noise). Most of the energy produced by airguns is below 200 Hz, although some high frequency noise may also be emitted (Goold 1996, Gordon and Moscrop 1998). Peak frequencies of seismic arrays are generally around 100Hz; source levels at higher frequencies are low relative to that at the peak frequency but are still loud in absolute terms and relative to background levels. In Cardigan Bay, Goold and Fish (1998) recorded 8 kHz sounds above background levels at a range of 8km from the source, even in a high noise environment.

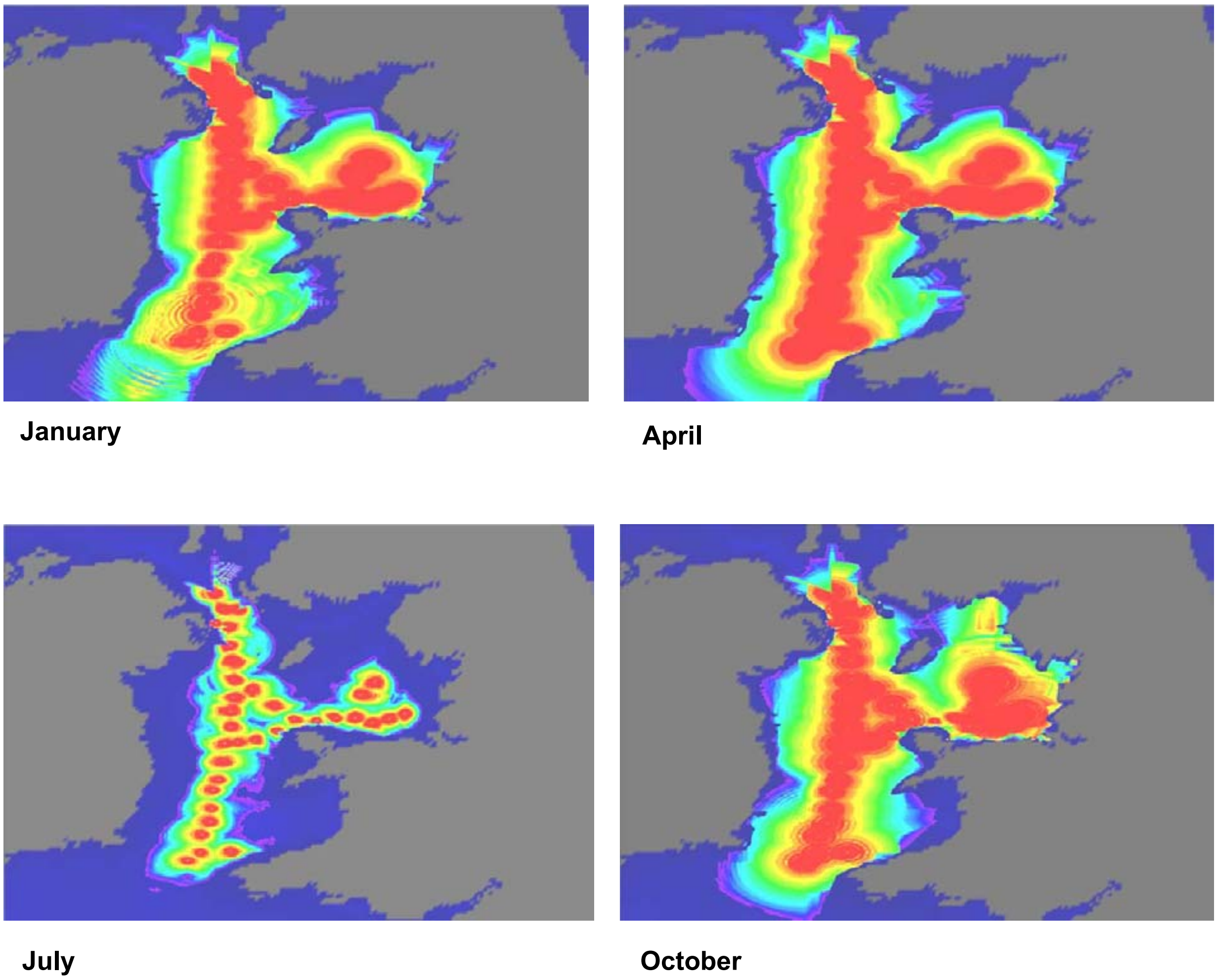
Figure 9.2 – Predicted dominant sources of ambient noise in the SEA 6 area



Source: Harland et al. (2005)

Figure 9.3 – Modelled ambient noise in the SEA 6 area, 10m depth

Source: Harland et al. (2005)



Available measurements indicate that drilling activities produce mainly low-frequency continuous noise (Richardson *et al*. 1995, Lawson *et al*. 2001). The primary sources of noise are various types of rotating machinery, with noise transmitted from a semi-submersible rig to the water column through submerged parts of the drilling unit hull, risers and mooring cables, and (to a much smaller extent) across the air-water interface. Under some circumstances cavitation of thruster propellers is a further appreciable noise source.

Measured farfield sound pressure associated with one floating drilling rig, indicated a SL defined in logarithmic units (dB), of around 170dB re. 1µPa, in the frequency range 10 - 2000Hz (Davis *et al.* 1991). This noise intensity is probably typical of drilling from a semi-submersible rig and is of the same order and dominant frequency range as that from large merchant vessels (e.g. McCauley 1994). Drilling noise has also been monitored west of Shetland, in the vicinity of the Foinaven and Schiehallion developments (Swift & Thompson 2000). High and variable levels of noise in three noise bands (1-10Hz, 10-30Hz and 30-100Hz) were initially believed to result from drilling related activity on two semi-submersible rigs operating in the area. However, subsequent analysis showed that noise events and drilling activity did not coincide. In contrast, a direct correlation between the use of thrusters and anchor handlers, during rig moves, and high levels of noise in all three bands was found (Swift & Thompson 2000).

Pipelay operations will result mainly in continuous noise (associated with rotating machinery), with relatively little impulse or percussive noise in comparison to many other marine construction activities. The overall source levels likely to result from pipelay operations are not known, however, near-field cumulative sound levels (i.e. overall received levels at some places within the near-field) associated with pipelay for the Clair project were predicted to be a maximum of 177dB (Lawson *et al*. 2001).

Although there is little published data, and no quantitative data available from previous activities in the Irish Sea, noise emission from production platforms is qualitatively similar to that from ships, and is produced mainly by rotating machinery (turbines, generators, compressors).

A further source of noise associated with all stages of offshore industry is helicopter overflights. There is relatively little quantitative information on the transmission of helicopter airborne noise to the marine environment (Richardson *et al*. 1995). Recent measurements of an air-sea rescue helicopter over the Shannon estuary (Berrow *et al*. 2002) indicated that due to the large impedance mismatch when sound travels from air to water, the penetration of airborne sound energy from the rotor blades was largely reflected from the surface of the water with only a small fraction of the sound energy coupled into the water.

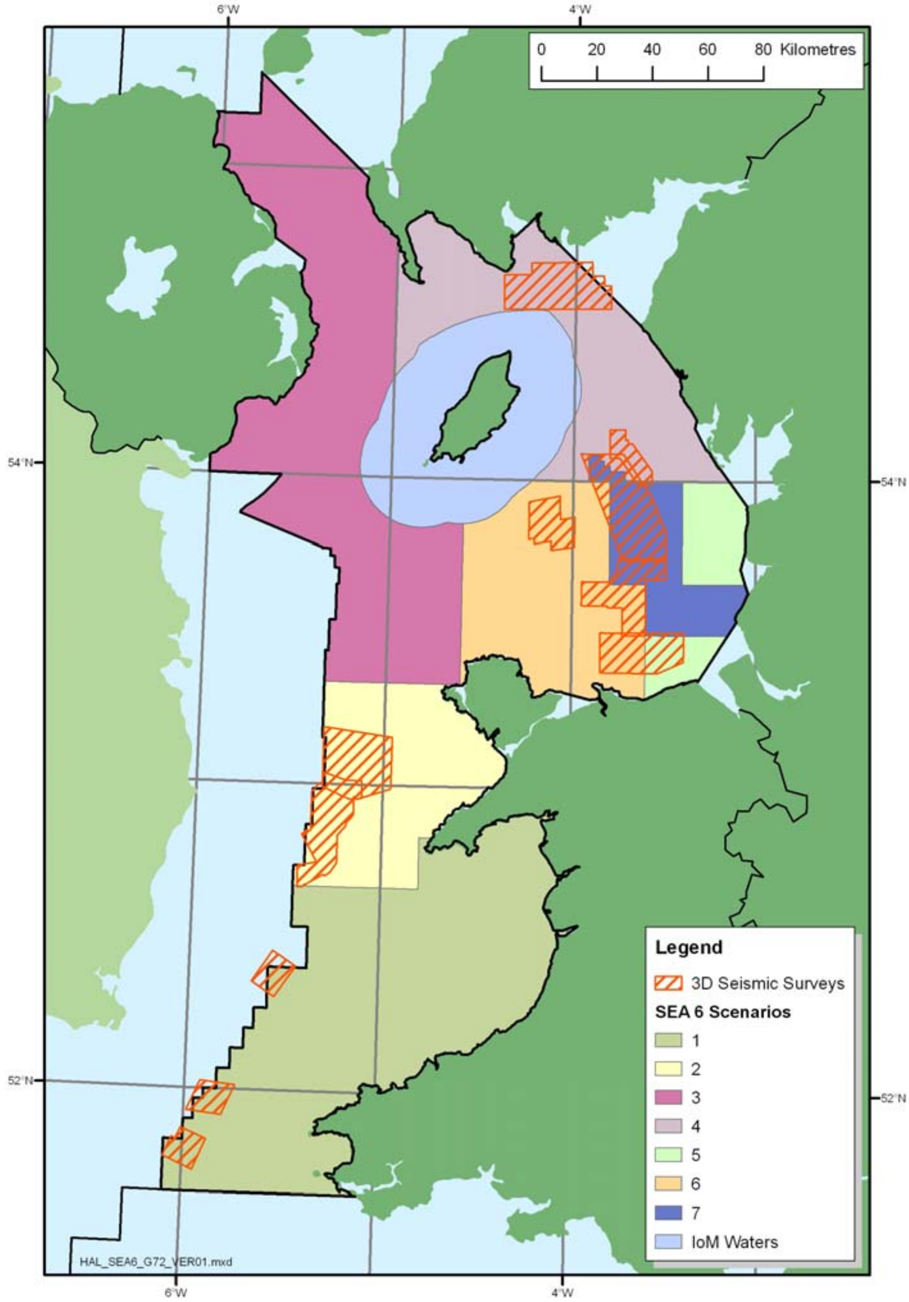
9.4.3 Sources and propagation of noise in relation to predicted activity scenarios

Activity scenarios for potential licences in the SEA 6 area assessment involve the possibility of 500km^2 3D seismic, and one exploration well, in each of scenario areas 1-7. In addition, possible seismic activity under existing licences comprises possible seismic in area 1 (St George’s Channel basin) if the Dragon appraisal proves successful; possible further seismic (500km^2 3D) in area 4 (East Irish Seas Basin, blocks 113/21 and 22); and likely new seismic in area 7 (mature Irish Sea) to delineate infield and near field potential.

As context, a total of 11 3D seismic surveys are recorded by the DEAL database from the SEA 6 area, conducted between 1993 and 1997. Spatial coverage and duration are not recorded consistently, although the total coverage is of the order of 3000 km^2 (Figure 9.4). The maximum forecast seismic activity is therefore approximately equivalent to the total coverage of 3D seismic in the SEA 6 area to date. With the exception of scenario area 3 (Western Irish Sea basin), all scenario areas have previous seismic activity.

A significant amount of 2D seismic has also been shot in the SEA 6 area under existing exploration and production licences.

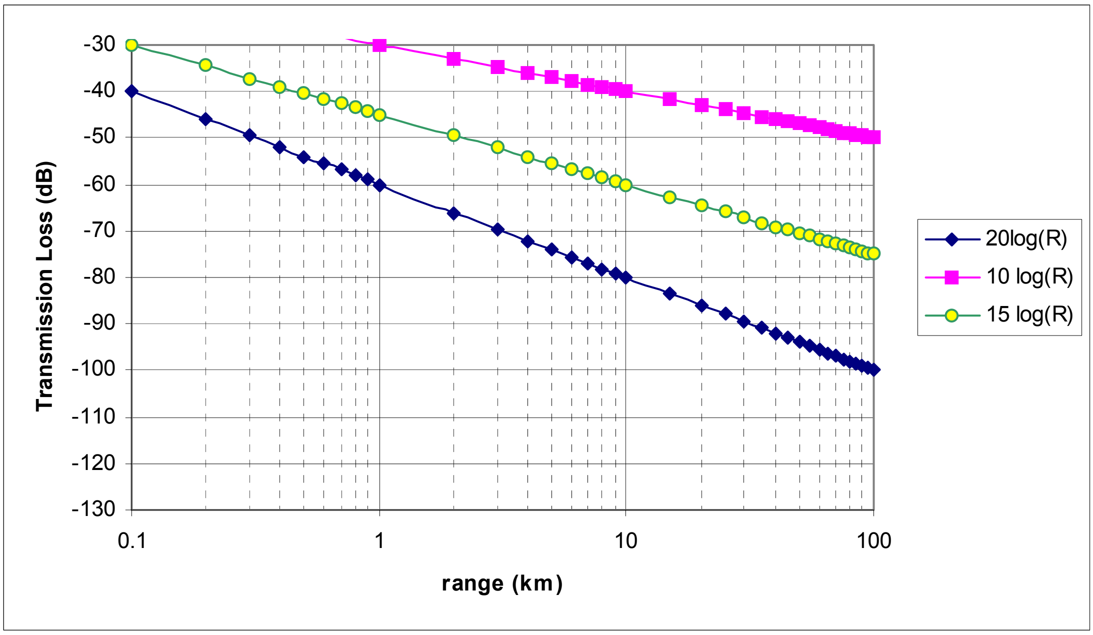
Figure 9.4 – Previous 3D seismic survey coverage in the SEA 6 area.



Source: UK DEAL database (www.UKDEAL.co.uk)

Most environmental assessments of noise disturbance use simple spherical propagation models of the form **SPL = SL – 20log(R)**, where SL = source level, R = source-receiver range, to predict sound pressure levels (SPL) at varying distances from source (Figure 9.5.). Cylindrical spreading, **SPL = SL – 10log(R)**, is usually assumed in shallow water, depth < **R**. However, several workers have measured or modelled additional signal modification and attenuation due to a combination of reflection from sub-surface geological boundaries, sub-surface transmission loss due to frictional dissipation and heat; and scattering within the water column and sub-surface due to reflection, refraction and diffraction in the propagating medium (see SEA 4). In shallow water, reflection of high frequency signals from the seabed results in approximately cylindrical propagation and therefore higher received spectrum levels than for spherically propagated low frequency signals (which penetrate the seabed). Attenuation of signal with distance is frequency dependent, with stronger attenuation of higher frequencies with increasing distance from the source. Frequency dependence due to destructive interference also forms an important part of the weakening of a noise signal. Simple models of geometric transmission loss may therefore be unreliable in relatively shallow water; in areas of complex seabed topography and acoustic reflectivity; where vertical density stratification is present in deep water; and where the noise does not originate from a point source.

Figure 9.5 – Theoretical Transmission Losses (TL) calculated for spherical spreading 20log(R), cylindrical spreading 10log(R) and intermediate spreading 15log(R).



Source: SEA 4 (DTI 2003)

Taking the upper limits of possible seismic activity, and assuming an acquisition rates of 25 km^2/day for 3D, the total predicted survey effort is approximately 200 days, over a possible 2-4 year timescale. It is likely that this would take place over two or three distinct periods (as Operators seek to maximise vessel utilisation), most likely during summer months of two or three years. It is unlikely that more than two or three surveys would be conducted simultaneously, due to vessel availability and potential interference between surveys.

Typical spatial extents of 3D seismic surveys are of the order of 25km in any direction (625 km^2 area). Assuming propagation distances of around 100km in all directions (see above), the theoretical instantaneous area of effect is a circular area of 31,400 km^2, and the total area ensonified during a survey is a rectangular area of 50,625km^2. The frequency spectrum will be modified over ranges >50km and peak received level in each seismic pulse will be reduced by time dispersion ("smearing") of the signal.

9.4.4 Sensitivities to acoustic disturbance

It is generally considered (e.g. by SEAs 1-5) that the most sensitive receptors of acoustic disturbance in the marine environment are marine mammals, due to their use of echolocation and vocal communication. Richardson *et al.* (1995) defined a series of zones of noise influence on marine mammals, which have been generally adopted by SMRU commissioned reports for SEAs 2 to 6 (Hammond *et al*. 2001, 2002, 2003, 2004, 2005); and in relation to which data on marine mammal responses have been exhaustively reviewed (e.g. Richardson *et al*. 1995, Gordon *et al*. 1998, Lawson *et al*. 2001, Simmonds *et al*. 2003). Four zones are recognised which will generally occur at increasing sound level: (1) the zone of audibility, (2) zone of responsiveness, (3) zone of masking and (4) zone of hearing loss, discomfort or injury. Potential acute effects include physical damage, noise-induced hearing loss (temporary and permanent threshold shifts) and short-term behavioural responses. Postulated chronic effects (for which evidence is almost entirely absent) including long term behavioural responses, exclusion, and indirect effects. The most likely physical/physiological effects are generally considered to be shifts in hearing thresholds and auditory damage.

Marine mammal distributions in the SEA 6 area are reviewed in Section 6.8, with the general conclusion that both cetacean and seal abundances are higher in the south of the area. Specific concentrations of marine mammal distribution are associated with the Cardigan Bay population of bottlenose dolphin and grey seal haul-out sites off the north coast of Wales, west of the Lleyn Peninsula, in the southern part of Cardigan Bay, west and south of Pembrokeshire, and southeast coast of Ireland. Harbour porpoises are more widely distributed over the SEA 6 area, and throughout the year; whereas short-beaked common dolphins are summer visitors to the St George's Channel. Risso's dolphin is a summer visitor to various coastal areas around north Wales and on either side of the St George's Channel. Harbour seals are found in relatively low numbers in the SEA 6 area, although larger breeding populations are present in the adjacent west coast of Scotland.

Research effort in the effects of anthropogenic noise on marine mammals has concentrated on seismic exploration, with a particular focus on baleen whales. With the exception of relatively low numbers of minke whales, the density (and therefore exposure risk) of baleen whales in the SEA 6 area is small. However, it is increasingly clear that airgun arrays produce significant energy over the frequency range in which behavioural audiograms suggest that dolphins are most sensitive. From acoustic monitoring of seismic surveys and visual monitoring of common dolphin during seismic surveys in the St George's Channel, Goold (1996) and Goold & Fish (1998) concluded firstly that dolphins were able to tolerate seismic pulses at a distance of 1 km from the array; and secondly that received levels at this distance were equivalent to a SPL of 133 dB re 1 μPa rms at 20 kHz (measured as power spectral density, re-calculated using a weighting method for comparison with a dolphin audiogram obtained using pure tone bursts). Actual behavioural responses to seismic noise have proved difficult to monitor, although Goold (1996) presented evidence which was initially interpreted as showing large scale, long term changes in abundance and distribution of common dolphins during a survey and shorter term changes in behaviour between periods when guns were on and off within a survey block in Cardigan Bay. In a later paper (Goold 1998), seasonal changes in the distribution of dolphins in the same area at the same time were revealed that may explain some, or all, of the larger scale changes previously attributed to seismic surveys. The later study analysed passive acoustic monitoring during the months September, October, November and December 1994 and 1995. Distributions of common dolphins within the survey area showed a marked decrease in dolphin contacts between September and October of both years. These observations suggest offshore migration of the populations at that time of year. It is hypothesised that offshore migration of common dolphins coincides with a break-up of the Celtic Sea Front, a distinct oceanographic feature which crosses the survey area.

Behavioural responses to anthropogenic noise have generally been studied by visual or acoustic monitoring of abundance. Visual monitoring of cetaceans during seismic surveys has been carried out for several years throughout the UKCS. Statistical analysis of 1,652 sightings during 201 seismic surveys, representing 44,451 hours of observational effort (and including a low amount of effort, <1000h, in the St George's Channel and Irish Sea), is reported by Stone (2003). Sighting rates of white-sided dolphins, white-beaked dolphins, *Lagenorhynchus* spp., all small odontocetes combined and all cetaceans combined were found to be significantly lower during periods of shooting on surveys with large airgun arrays. In general, small odontocetes showed the strongest avoidance response to seismic activity, with baleen whales and killer whales showing some localised avoidance, pilot whales showing few effects and sperm whales showing no observed effects.

There have been far fewer studies of marine mammal responses to continuous drilling noise (Richardson et al. 1995), with most available data relating to baleen whales. Sorensen et al. (1984) observed distributions of a similar range of small cetacean species to that found around the proposed well location (including common, Risso's, bottlenose and Stenella dolphins), in the vicinity of drilling activities off New Jersey, and reported no difference in sightings per unit effort with and without the presence of rigs.

Other effects of sound have been postulated, including triggering the onset of Decompression Sickness (DCS) either through behavioural modification or direct physical activation of microbubbles. Probably more meaningful in an SEA 6 context, concerns have been raised that the cumulative effect of sequential seismic surveys could act as a barrier to migration, for example in relation to the Atlantic Margin area. Gordon et al. (1998) considered that sound fields from planned seismic surveys in 1997, assuming a spherical propagation model and a threshold intensity of 160dB re 1 µPa, would form a "virtually unbroken barrier to any marine mammal wishing to move north-south along the shelf edge". Available evidence does not suggest regular migratory movements of marine mammals in the SEA 6 area (i.e. through the St George's and North Channels) and there is no UK or international data suggesting that broadscale marine mammal distribution patterns have been influenced by seismic activity to date. Nevertheless, successive seismic surveys could have a cumulative effect on animal distribution and movements as a result of repetitive behavioural disturbance – although based on the SEA 6 activity scenarios this is not expected.

In addition to marine mammals, effects of noise are possible in other species. Many species of fish are highly sensitive to sound and vibration (reviewed by MMS 2004), and effects on fishing success ("catchability") have been demonstrated following seismic survey (Pearson et al. 1992, Skalski et al. 1992, Engås et al. 1993). MMS (2004) consider that the "consensus is that seismic airgun shooting can result in reduced trawl and longline catch of several species when the animals receive levels as low as 160 dB". However, no associations of lower-intensity, continuous drilling noise and fishing success have been demonstrated, and large numbers of fish are typically observed around North Sea and other production platforms.

Planktonic and benthic invertebrates generally do not have gas-filled body cavities and are considered less susceptible to acute trauma and behavioural disturbance resulting from noise and vibration. Cephalopods, with a well-developed nervous system and complex behavioural responses, are a possible exception (although they lack resonating structures analogous with the middle ears, lungs, tracheal cavities and sinuses of mammals).

In contrast to other SEA areas (where activity is concentrated offshore), there is a possibility of nuisance noise associated with nearshore seismic surveys, drilling or production in the SEA 6 area. Previous seismic surveys in the northern part of the area are reported to have resulted in complaints of noise transmission via domestic plumbing.

9.4.5 Control and mitigation of acoustic disturbance

Both planning and operational controls cover acoustic disturbance resulting from seismic surveys and other E&P activities on the UKCS. Regulation 10 of *The offshore petroleum activities (conservation of habitats) Regulations 2001* states that oil and gas activities shall not deliberately disturb any creature listed on Annex IVa of the Habitats Directive (which includes all cetaceans), nor cause deterioration or destruction of breeding sites or resting places of any such creature. Application for consent to conduct seismic and other geophysical surveys is made using *Petroleum Operations Notice No 14* (PON14) supported by an Environmental Narrative to enable an accurate assessment of the environmental effects of the survey. Consultations with Government Departments and other interested parties are conducted prior to issuing consent, and JNCC may request additional risk assessment, specify timing or other constraints, or advise against consent.

Within the SEA 6 area, any proposed activity with a potential acoustic impact within the Cardigan Bay, Lleyn Peninsula or Pembrokeshire marine SACs would also be subject to the requirement for Appropriate Assessment under the *Conservation (Natural Habitats, &c.) Regulations 1994*, which apply within territorial waters.

The major operational control and mitigation over seismic surveys in the UK are through JNCC's *Guidelines for minimising acoustic disturbance to marine mammals from seismic surveys (April 2004)*. These were originally introduced on a voluntary basis as part of the UK's commitment under ASCOBANS, but have subsequently been required by licence conditions and through the PON14 approval process.

Under the Guidelines there is a requirement for visual monitoring of the area (and acoustic surveys in sensitive areas) prior to seismic testing to determine if cetaceans are in the vicinity, and a slow and progressive build-up of sound to enable animals to move away from the source. The guidelines have been revised a number of times (e.g. the latest version incorporates various recommendations made by Stone (2003)) and appear to be reasonably effective.

9.4.6 Summary of potential effects

In relative terms, and in the overall context of the UKCS, the sensitivity of much of the SEA 6 area to acoustic disturbance is moderate or low, and exposure to ambient noise is high. Marine mammal populations, which dominate noise sensitivity in offshore habitats north and west of Britain, have fewer species and lower abundance than in more oceanic SEA areas with relatively well-understood "hotspots" of distribution. The areas of SEA 6 with most marine mammal sensitivity (St. Georges Channel and Cardigan Bay) do not coincide with the areas of greatest anticipated seismic activity, and are at sufficient distance (>100km) that most of the predicted surveys will have no effect.

The balance of evidence suggests that effects of seismic activities are limited, in species present in significant numbers within the SEA 6 area, to behavioural disturbance which is likely to be of short duration, limited spatial extent and of minor ecological significance. The numbers of individuals likely to be influenced represent a small proportion of biogeographic populations. Existing control and mitigation methods are believed to be generally effective in preventing physical damage. There is limited seasonality to overall sensitivity of marine mammals in offshore areas, although there are increased sensitivities associated with the summer/autumn distribution of common and Risso's dolphin in the St. George's Channel.

Other sources of noise from exploration and production produce continuous noise at lower source levels, which are unlikely to have a significant effect on marine mammal populations.

The proposed seismic activity levels are similar to those previously undertaken in the area, which are not known to have resulted in significant environmental effects. Local, short-term effects of seismic surveys on other activities, such as fishing, are possible but will be dominated by physical exclusion, which is mitigated and managed through established consultation and communication procedures.

9.4.7 Conclusions and data gaps

In relative terms, and in the overall context of the UKCS, the sensitivity of much of the SEA 6 area to acoustic disturbance is moderate or low, and exposure to ambient noise is high. Marine mammal populations, which dominate noise sensitivity in offshore habitats north and west of Britain, have fewer species and lower abundance than in more oceanic SEA areas with relatively well-understood "hotspots" of distribution. The areas of SEA 6 with most marine mammal sensitivity (St. Georges Channel and Cardigan Bay; scenario areas 1 and 2) do not coincide with the areas of greatest anticipated seismic activity, and are at sufficient distance (>100km) that most of the predicted surveys will have no effect.

The balance of evidence suggests that effects of seismic activities are limited, in species present in significant numbers within the SEA 6 area, to behavioural disturbance which is likely to be of short duration, limited spatial extent and of minor ecological significance. The numbers of individuals likely to be influenced represent a small proportion of biogeographic populations. Existing control and mitigation methods are probably generally effective in preventing physical damage. There is limited seasonality to overall sensitivity of marine mammals in offshore areas, although there are increased sensitivities associated with the summer distribution of short beaked common and Risso's dolphin in the St George's Channel (scenario areas 1 and 2).

Other sources of noise from exploration and production produce continuous noise at lower source levels, which are unlikely to have a significant effect on marine mammal populations.

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Ongoing work, in part funded through the DTI SEA process, is helping to fill remaining significant gaps in understanding of marine mammal distribution and abundance. As noted above, understanding of ambient noise is limited and recommendations were made by Harland *et al*. (2005) for further field measurement and modelling. However, the issue of anthropogenic ambient noise involves many industrial sectors (e.g. fishing and shipping) and recreation and would be best addressed through collaborative initiatives. Current understanding is considered adequate for the purposes of this assessment.

Previous DTI SEAs have noted the widespread consensus in the academic community that controlled exposure experiments represent the most objective approach to reducing uncertainty in assessing acoustic effects on cetaceans; although it is also recognised that such experiments may have considerable practical and ethical difficulties (Tyack *et al*. 1993, Hammond *et al*. 2004). Within appropriate international collaborative frameworks, it is recommended that UK stakeholders participate in this approach, in order to maximise the relevance of resulting information to UK habitats and species. A similar recommendation was made by the draft report of the IACMST Working Group (August 2005).

9.5 Physical damage to features and biotopes

9.5.1 Physical damage to biotopes and other seabed sensitive features

Several activities associated with exploration and production can lead to physical disturbance of seabed habitats and geomorphological features, with consequent effects on benthic communities and potentially on archaeological artefacts. The main sources of disturbance are:

- Anchoring of semi-submersible rigs
- Placement of jack-up rigs (seabed disturbance by spud cans)
- Drilling of wells and wellhead removal
- Production platform jacket installation (and piling)
- Subsea template and manifold installation (and piling)
- Pipeline, flowline and umbilical installation and trenching
- Decommissioning of infrastructure

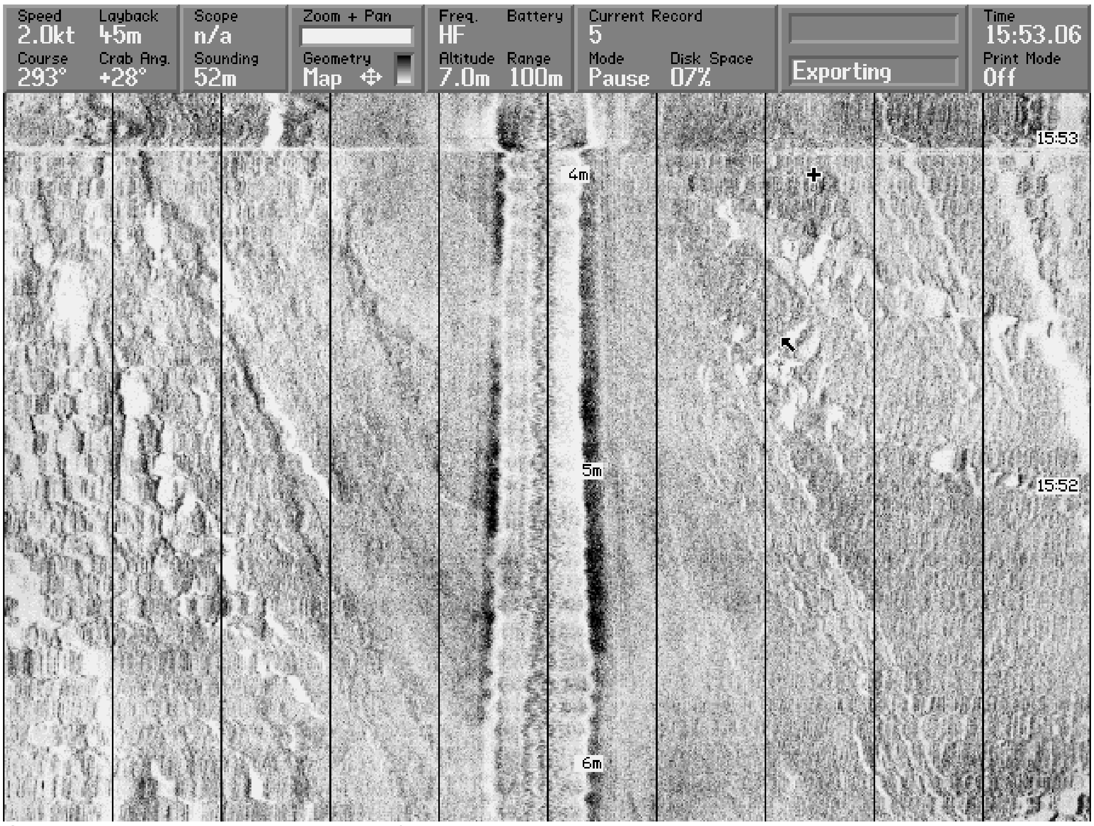
Previous SEAs have compared the disturbance effects of oilfield activities to those of fishing and natural events in shallow water (e.g. storm wave action), concluding that oilfield effects are typically minor on a regional scale. It is generally accepted that the principal source of human physical disturbance of the seabed and seabed features, is trawling. Trawl scarring is a major cause of concern with regard to conservation of shelf and slope habitats and species (e.g. Witbaard & Klein 1993, de Groot and Lindeboom 1994, Kaiser *et al*. 2002a, Kaiser *et al*. 2002b, Gage *et al*. 2005). Estimates of the intensity of trawling disturbance, and of the resilience and recovery timescale of benthic communities vary, although a conservative estimate of the scale of effect (assuming a fishing effort of 2000 hours per year per 0.5º ICES rectangle) is of the order of several billion square metres per year of trawl scar in the North Sea.

On the basis of known fishing activities, trawl scarring is likely to be present over much of the SEA 6 area seafloor, with the effects of scallop dredging particularly significant (since the gear is more damaging and sensitive habitats such as biogenic reefs may be affected). Trawl / dredge scarring was evident in much of the sidescan coverage acquired in support of SEA 6 (see example in Figure 9.6).

Although the depth of sediment over-turned of some E&P activities may be greater (and therefore possibly a longer recovery timescale) and it is also possible that fishing effort may reduce in future, the contribution of E&P in the SEA 6 area to cumulative disturbance of the seabed (of the order of 0.1-1% of fishing-related disturbance) is not considered likely to be significant.

The broadscale distribution of biotopes of conservation importance is relatively well understood (see Sections 5.2, 6.3) and it is believed that the effects of the range of potential SEA 6 activities would be mitigated to acceptable levels by existing controls. In the SEA 6 area, areas of methane-derived authigenic carbonate and biogenic reefs including horse mussel (*Modiolus*) beds – and possibly herring spawning grounds – would be of particular concern in relation to physical disturbance. Site-specific, pre-activity assessment and survey can be expected to identify the presence of sensitive features and therefore allow either for further investigation and/or alterations to planned activities to mitigate potential disturbance.

Figure 9.6 - Scallop dredge scarring



Sidescan sonar image taken north of Anglesey – there are paired tracks made by a scallop dredger on the right hand side of the image, with other less clear marks on the left. The 'combed' appearance of the tracks indicates they were made by multiple dredges towed on gang bars rather than by beam trawls. The tracks cross some of the narrow mound features that may represent Modiolus *beds in this area Source: Rees (2005)*

In the case of Natura 2000 conservation sites (including potential offshore sites which may be designated in future; see Section 7.3), existing controls on oil and gas activities include the requirement for an Appropriate Assessment before consent for the proposed activity can be given.

On the basis that seabed disturbance is qualitatively similar to the effects of severe storms; it is likely that that sand and gravel habitat recovery from the processes of anchor scarring, anchor mounds and cable scrape is likely to be relatively rapid (1-5 years) in most of the shallower parts of the SEA 6 area. Muddier sediments west of the Isle of Man (and locally elsewhere), support benthic communities characterised by the presence of large burrowing crustaceans (*Nephrops norvegicus* and the thalassinids *Calocaris macandreae, Callianassa* spp. and *Upogebia* spp.), echiurans (e.g. *Maxmulleria lankesteri*) and fish. *Nephrops* and *Calocaris* are able to restore burrow entrances following limited physical disturbance of the sediment surface (a few cm), although this habitat is probably more sensitive to physical disturbance than coarser sediments typical of high wave- and current-energy areas.

9.5.2 Archaeology

Oil and gas activities also have the potential to damage archaeological artefacts and sites, in particular through the trenching of pipeline into the seabed and through rig anchoring. The most prospective areas for prehistoric archaeological remains in the SEA 6 area are in the shallows along the north coast of Wales, around Anglesey, south east off the Isle of Man, in the sheltered waters around the Stranraer peninsula, and the loughs of Northern Ireland

(Fleming 2005). Evidence of more recent maritime archaeology primarily in the form of shipwrecks is relatively common from the 17th century onwards (see Section 7.4).

However, in addition to the potential for damage, oil and gas activity is also recognised to present the opportunity to provide beneficial new archaeological data, for example through rig site or pipeline route mapping and sediment coring. Fleming (2005) therefore suggests that rather than seeking to prevent or limit oil and gas activities, "it is therefore in the interests of long term preservation of the archaeological sites, and in the interests of acquisition of archaeological knowledge, that we use industrial and commercial activities as a means of identifying archaeological prehistoric sites in the offshore area". The recognition of the importance of prehistoric submarine archaeological remains has led to a number of recent initiatives.

The legal and policy framework for protection of maritime archaeology are described by Wessex Archaeology (2005). Guidance on current good practice is outlined in the JNAPC Code of Practice for Sea Bed Operators with a revised version due shortly. A guidance booklet for the aggregates industry has been published (BMAPA and English Heritage, 2003) covering legislation, statutory controls, possible effects of aggregate extraction, obtaining archaeological advice, assessment, archaeological investigation, mitigation, and monitoring. Similar guidance for the offshore oil and gas industry has been produced by the Unive

9.5.3 Conclusions and data gaps

Physical disturbance resulting from proposed SEA 6 activities will be small in scale and duration, in comparison to natural disturbance and the effects of demersal fishing, and will be mitigated to acceptable levels by existing controls.

The broadscale distribution of biotopes of conservation importance is relatively well mapped, and sufficient information is available to assess the probability of sensitive habitats in proximity of proposed activities. Similarly, specific project can be assessed in terms of likelihood of significant archaeological features. In both cases, however, detailed site surveys (which are routinely acquired prior to drilling or development operations) should be evaluated with regard to environmental and cultural sensitivities. Where the likelihood of sensitive features is high – predominantly in parts of scenario areas 1, 2 and 3 – the scoping of site surveys should be reviewed by relevant conservation and heritage agencies.

9.6 Physical presence

The potential interactions between oil and gas activities and other users of the sea, in particular fishermen and shipping, together with the various mitigation measures were described in detail in SEA 5 (Section 10.3) and these are not reiterated here. Three additional aspects are considered in the following sections.

9.6.1 Marine spatial planning

In light of the Defra marine spatial planning pilot study being carried out in the Liverpool Bay area, the potential interactions of activities that could follow further oil and gas licensing are considered below. There is the potential for overlap in the areas of interest for hydrocarbon and windfarm (and other renewable energy) developments. However, since the regulator for both industries is the DTI, such potential conflicts as may occur can be expected to be resolved at the licensing/leasing and project approvals stages. In advance of any potential future marine spatial plan, there are already a number of areas (such as shipping traffic separation schemes, and air exclusion zones) where other potential activities may be curtailed in the interests of navigation safety. Such areas are already considered by the DTI in consultation with other government departments/agencies during the licensing process. As a result certain Blocks (or parts of Blocks) are already excluded from licensing or have stringent activity restrictions placed on them (e.g. no exploration drilling may be undertaken from within the Block). The anticipated spatial focus and scale of exploration activity (and likely methods of development) are such that limited interaction is predicted with other existing or potential uses of the sea.

9.6.2 Visual intrusion

The potential for visual intrusion was raised in the Assessment Workshop and through scoping feedback from the Consultation Bodies. Some existing production platforms in Liverpool Bay are visible from shore (the Lennox platform is some 7km from the coast) although their presence is temporary, with current projections indicating decommissioning by 2015 (BHP Billiton 2001). Development of known small "stranded" reservoirs and potential new discoveries (in existing licensed acreage or in Blocks awarded in the 24th Round if implemented) could extend the production life of some facilities, although new developments are likely to be a sub-sea tiebacks to existing platforms (and hence have no above surface structures). In the event of new field developments, there would be temporary vessel presence during construction and maintenance but given the scale of existing commercial and recreational vessel traffic in the area, this is not viewed as significant additional visual intrusion.

9.6.3 Ecological interactions

Physical presence of infrastructure and support activities may cause behavioural responses in fish, birds and marine mammals. The majority of such interactions (whether positive or negative) are viewed as insignificant. However, large numbers of seaduck and in particular common scoter occur in the shallow waters of Liverpool Bay and these appear to be susceptible to disturbance e.g. dispersal of feeding or roosting flocks by surface vessel passage in proximity or aircraft low overflight. If substantial, such disturbance could become locally significant and require mitigation for example through tightly defined vessel traffic routes or timings. Parts of inner Liverpool Bay are being considered as a potential offshore SPA and if so designated, Appropriate Assessments would be required for permitting of existing and new hydrocarbon developments and associated activities in the area. For this reason it is concluded that existing oil and gas industry control mechanisms are likely to be effective in mitigating potential impacts on these sensitive receptors and that consequently Blocks need not be excluded from potential offer in a 24th Licensing Round.

The physical presence of structures in the sea provides hard surfaces for biological colonisation. The development and succession of this fouling growth on North Sea production platforms has recently been summarised by Whomersley & Picken (2003) and similar patterns can be expected in the Irish Sea. Fouling growth can result in a number of subtle ecological impacts (e.g. enrichment) in the vicinity of the structure but these are not regarded as significant effects.

9.6.4 Conclusion and data gaps

The UK oil and fishing industries have successfully co-existed for over 30 years. Although exclusion could represent a significant conflict between fishing and hydrocarbon production in intensively developed areas within established fishing grounds, the spatial extent of predicted temporary and permanent exclusion zones is unlikely to cause significant economic impacts. Additional in-field and export pipelines will be few in number, and designed to minimise risks of interactions with trawl gear. Short-term disruption to inshore fixed gear fisheries (mainly shellfish trapping) may occur during seismic survey and pipeline construction, although in view of the predicted level of activity in the SEA 6 area this disruption will be limited. The oil industry and UK fishing industry maintain consultation, liaison and compensation mechanisms, which should serve to mitigate and resolve any conflicts.

No significant visual intrusion is predicted based on the anticipated nature and scale of activities. The lack of seascape baseline documentation for England is noted, in contrast to the situation in Wales and Scotland.

Common scoter are regarded as sensitive to disturbance in NW European waters in contrast to off US and Canadian coasts where they appear tolerant of disturbance. An understanding of the reasons for this dichotomy (if validated) would be useful in considering appropriate mitigation in the SEA 6 area and adjacent waters.

9.7 Marine discharges

As described in previous SEAs, marine discharges from exploration and production activities include produced water, sewage, cooling water, drainage, drilling wastes and surplus WBM, which in turn may contain a range of hydrocarbons in dissolved and suspended droplet form, various production and utility chemicals, metal ions or salts (including Low Specific Activity (LSA) radionuclides). In addition to these mainly platform-derived discharges, a range of discharges is associated with operation of subsea infrastructure (hydraulic fluids), pipeline testing and commissioning (treated seawater), and support vessels (sewage, cooling and drainage waters). The effects of the majority of these are judged to be negligible and are not considered further here (note, they would be considered in detail in Environmental Statements and chemical risk assessments under existing permitting procedures).

Discharges from offshore oil & gas facilities have been subject to increasingly stringent regulatory controls over recent decades, and oil concentrations in the major streams (drilling wastes and produced water) have been substantially reduced. However, due mainly to increasing water cut from mature oil reservoirs, and the use of water injection to maintain reservoir pressure, the total volume of produced water discharges on the UKCS has increased and is expected to continue to increase in the foreseeable future (DTI website http://www.og.dti.gov.uk/environment/index.htm).

9.7.1 Produced water

Produced water is derived from reservoir ("fossil") water and through condensation. The majority of produced water discharge volume to the North Sea and elsewhere is associated with oil production and produced water volumes from gas fields are extremely small in comparison. The chemical composition and effects of produced water discharges have been previously summarised in SEAs 2 and 3 and are not repeated here.

OSPAR Recommendation 2001/1 for the Management of Produced Water from Offshore Installations provides for a reduction in the discharge of oil in produced water by 15% over a five year period and a lowering of the discharge concentration from each installation to 30mg/l over the same period. The recommendation also includes a presumption against the discharge to sea of produced water from new developments. Fundamental to the consideration of potential effects of produced water in the SEA process is the assumption that reinjection will be the normal method of produced water disposal (at least 95% by volume), although under certain circumstances (e.g. injection pump maintenance) the effluent may be routed to sea. Any produced water discharged will be treated since it is still required to meet legal quality standards in terms of oil in water concentration.

Potential effects of produced water discharges are described in previous SEAs. Most studies of produced water toxicity and dispersion (see E&P Forum 1994, OLF 1998) have concluded that the necessary dilution to achieve a No Effect Concentration (NEC) would be reached at 10 to 100m and certainly less than 500m from the discharge point. The SEA 6 commissioned study (Kenny *et al*. 2005) reviewed recent studies and data (including analyses of produced water composition from Irish Sea facilities), and reached a similar conclusion. Kenny *et al*. (2005) also assessed potential endocrine disruption associated with alkylphenols from the degradation of alkylphenol ethoxylates, added as production chemicals to certain offshore procedures, using available data from the Douglas platform.

The recent ICES Biological Effects Monitoring in Pelagic Ecosystems workshop (BECPELAG) was a multi-national, multi-discipline study looking at techniques suitable for monitoring the medium to longer term effects of contaminants on pelagic (open water, or offshore) ecosystems (www.iis.niva.no/PELAGIC/web/participants_only/wrap-up%20conference/overview.htm). Samples from caged organisms and passive samplers were analysed using a wide range of biomarkers and bioassays for chemical, molecular, cellular and physiological changes. Although a variety of detectable responses (in caged organisms) to proximity to an oil platform were observed and attributed to produced water effects, the ecological significance of these responses is unclear.

9.7.2 Drilling wastes

Drilling wastes are a major component of the total waste streams from offshore exploration and production, with typically around 1,000 tonnes of cuttings resulting from an exploration or development well. Water-based mud cuttings are discharged at, or relatively close to sea surface during "closed drilling", whereas surface hole cuttings will be discharged at seabed during "open-hole" drilling. Use of oil-based mud systems, for example in highly deviated sections or in water reactive shale sections, would require the onshore disposal or reinjection of the waste materials.

The contaminant composition of drilling wastes has changed significantly over the last few decades, in response to technical and regulatory developments. Previous widespread and substantial discharges of oil-based muds, and later synthetic muds, have been superseded by alternative disposal methods (either containment and onshore treatment, or reinjection) or by use of water-based muds.

Mud systems used in surface hole drilling for exploration wells are usually simple (seawater with occasional viscous gel sweeps) and would not result in significant contamination of sediments. However, the composition of closed drilling discharges likely to result from exploration, appraisal and development drilling (and to a lesser extent from well maintenance activities) is more complex, and will include cuttings (i.e. formation solids, in varying degrees of consolidation and in a range of particle sizes), barite, salts (sodium and potassium chloride), bentonite and a range of mud additives in much smaller quantities. Water-based mud additives perform a number of functions, but are predominantly polymeric organic substances and inorganic salts with low toxicity and bioaccumulation potential. In addition to mud on cuttings, surplus water-based mud may be discharged at the sea surface during or following drilling operations. Due to its density, a proportion of the particulate component of the mud (including barite) may settle in the vicinity of the discharge point.

A major insoluble component of water-based mud discharges, which will accumulate in sediments, is barite (barium sulphate). Barite has been widely shown to accumulate in sediments following drilling (reviewed by Hartley 1996). Barium sulphate is of low bioavailability and toxicity to benthic organisms. Other metals, present mainly as salts, in drilling wastes may originate from formation cuttings, from impurities in barite and other mud components or from other sources such as pipe dopes. Although a variety of metals (especially chromium) are widely recorded to accumulate in the vicinity of drilling operations, the toxicity of settled drill cuttings appears to be related primarily to hydrocarbon content, even in WBM discharges; probably because in the past hydrocarbon spotting fluids had been used as a contingency measure (UKOOA 2002, Hartley Anderson 2003).

Dispersion of mud and cuttings is influenced by various factors, including particle size distribution and density, vertical and horizontal turbulence, current flows, and water depth. In deep water, the range of cuttings particle size results in a significant variation in settling velocity, and a consequent gradient in the size distribution of settled cuttings, with coarser material close to the discharge location and finer material very widely dispersed away from the location, generally at undetectable loading. One example of modelling of the distribution of discharged drill cuttings was undertaken for the Dragon discovery well in the St George's Channel by the University of Wales, Bangor (Elliott & Jones 1993). The results indicated a cuttings spread in an elongated ellipse along the axis of tidal current movement (NE-SW), with a very rapid attenuation of the depth of cuttings deposition with increasing distance from the well. Coarse particles would settle very close (ca. 25m) to the wellhead in a layer around 6cm deep and medium sand size particles would settle at distances of between 200 and 500m from the well with an average depth of about 1.5mm. The finest particles modelled were predicted to settle over an area of the order of 40km by 30km with the depth of deposition being less than 1 micron. The conclusion of the report was that actual depositional patterns would be more diffuse than that suggested by the model results and that the concentrations would be negligible (and insignificant in the context of naturally occurring particulates) at distances of more than a few hundred metres from the wellhead.

In contrast to historic oil based mud discharges, effects on seabed fauna of the discharge of cuttings drilled with WBM and of the excess and spent mud itself are usually subtle or undetectable, although the presence of drilling material at the seabed close to the drilling location (<500m) is often detectable chemically (e.g. Cranmer 1988, Neff *et al*. 1989, Hyland *et al*. 1994, Daan & Mulder 1996). Considerable data has been gathered from the North Sea and other production areas, indicating that localised physical effects are the dominant mechanism of ecological disturbance where water-based mud and cuttings are discharged.

However, Cranford & Gordon (1992) reported low tolerance of dilute bentonite clay suspensions in sea scallops (*Placopecten magellanicus*). Cranford *et al*. (1999) found that used water based mud and its major constituents, bentonite and barite caused effects on the growth, reproductive success and survival of scallops, which were attributed to chronic toxicity and physical disturbance. It may be that *Placopecten* is especially sensitive to drill muds (or fine sediments in general) or that in the field, water based drilling discharges very rapidly disperse to below effective concentrations. Barlow and Kingston (2001) report damage to the gills of two species of coastal bivalves where barite was added to experimental system although no controls with other sediment added were tested and the concentrations of material added were very high so it is unclear how or if the results apply to the field situation. This work is being taken further through a UKOOA funded PhD studentship at Heriot-Watt University commencing autumn 2005.

Most studies of ecological effects of drilling wastes have involved soft-sediment species and habitats. Studies of the effects of water based mud discharges from 3 production platforms in 130-210m off California found significant reductions at some stations in the mean abundance of 4 of 22 hard bottom taxa investigated using photographic quadrats (Hyland *et al*. 1994). These effects were attributed to the physical effects of particulate loading, namely disruption of feeding or respiration, or the burial of settled larvae.

9.7.3 Other discharges

The actual or potential introduction of non-native species through vessel ballast water discharges or from fouling organisms on vessel/rig hulls has been an issue of increasing concern. Introduced, non-native species can have a number of negative effects including algal blooms and ecological impacts through predation, resource competition or habitat exclusion of native species. In response to this, a number of technical and procedural measures have been proposed (such as the use of ultraviolet radiation to treat ballast water) or introduced such as a mid-ocean exchange of ballast water (the most common mitigation against introductions of non-native species). In addition, the International Maritime Organisation (IMO) has introduced guidelines for the control and management of ships' ballast water (originally proposed in Agenda 21 at the United Nations Conference on Environment and Development (UNCED) in 1992, and adopted in Resolution A.868 (20) Agenda item 11, in 1997).

The potential for significant effects arising from oil and gas activities involving ballast water discharge as a direct result of E&P activities on the UKCS area is limited to discharges from rigs which have transited over considerable distances, since other ballast discharges (e.g. from shuttle tankers) are unlikely to contain non-native species. Since water depths throughout most of the SEA 6 area would allow the use of jack-up drilling rigs (with the exception of the St. George's Channel (scenario area 1), the risk of accidental introductions by this route is considered to be very low, and to make a negligible contribution to the overall risk associated with general shipping.

The introduction of non-native species from fouling growths on vessels and rigs has received less attention than those from ballast water but are potentially ecologically and economically significant (e.g. the introduction of the zebra mussel *Dreissena polymorpha* to the North American Great Lakes). Shipping is the most important source of introductions from fouling growths primarily affecting ports and adjacent coasts with hard substrata (Hayes *et al*. 2005). Kerckhof & Cattrijsse (2001) recorded 9 exotic species of barnacles from navigation buoys off the Belgian coast, some in breeding condition suggesting the possibility of self-sustaining populations. Mitigation relies mainly on the use of antifouling coatings and hull cleaning. In the case of potential activities resulting from a 24th licensing round, the vast majority of rigs and vessels used will already be operating in NW Europe and hence not a potential source of exotic species introductions (although they could facilitate the spread of species).

9.7.4 Sensitive habitats and species

Some benthic habitats and species within the SEA 6 area are both of conservation interest, and may be sensitive to the effects of particulate discharges. These include biogenic "reef" communities dominated by *Modiolus*, *Sabellaria* (and possibly *Limaria*), (see Sections 5.2, 6.3).

As noted above, ecological effects of water-based mud and cuttings discharges are generally minor, with the possible exception of the effects of high loadings of fine particulates on bivalve molluscs. The latter lab-based experimental findings probably represent physical effects relevant only to the immediate vicinity of drilling discharges. Natural suspended solids loadings, and bed-load transport, are both high in the Irish Sea (Section 5.2) and habitats and communities must have a relatively high tolerance to suspended particulates.

Existing regulatory mechanisms provide a high degree of protection to *Modiolus* and other sensitive species where these are known to occur (i.e. the Conservation of Habitats regulations apply to "relevant sites" whether these are designated or not).

9.7.5 Conclusions and data gaps

The environmental effects of the major discharges from oil and gas activities have been extensively studied, and are considered to be relatively well understood. The environmental effects of produced water discharges not reinjected are limited primarily by dispersion, below NEC. Discharges of WBM cuttings in the North Sea and other dispersive environments have been shown to have minimal ecological effects.

9.8 Atmospheric emissions

9.8.1.1 Introduction

Gaseous emissions from offshore exploration and production of oil and gas contribute to global atmospheric concentrations of greenhouse gases, regional and local acid gas loads and potentially to local tropospheric ozone and photochemical smog formation.

9.8.1.2 Sources

The major sources of emissions to atmosphere from offshore oil and gas exploration and production are internal combustion for power generation by installations, terminals, vessels and aircraft, flaring for pressure relief and gas disposal, flaring from well clean-up and testing, cold venting from storage and loading operations and fugitive emissions.

Power requirements for the UK offshore industry are dominated by oil production installations (typically >50MW per platform), with smaller contributions from gas platforms and mobile drilling units (typically 10MW per unit) and support vessels. The major energy requirement for production is compression for injection and export, with power generated by gas or dual-fuel turbine. Gas, fuel and diesel consumption accounted for 79% of total CO_2 emissions from the UKCS in 2004 (EEMS 2005).

Flaring from existing UKCS installations has been substantially reduced relative to past levels, largely through continuing development of export infrastructure and markets, together with gas cycling and reinjection technologies. Total flaring (excluding terminals) on the UKCS was 1,372,893 tonnes in 2004 (an increase of approximately 2.3% above 2003 figures), compared to 1,699,978 tonnes in 1999.

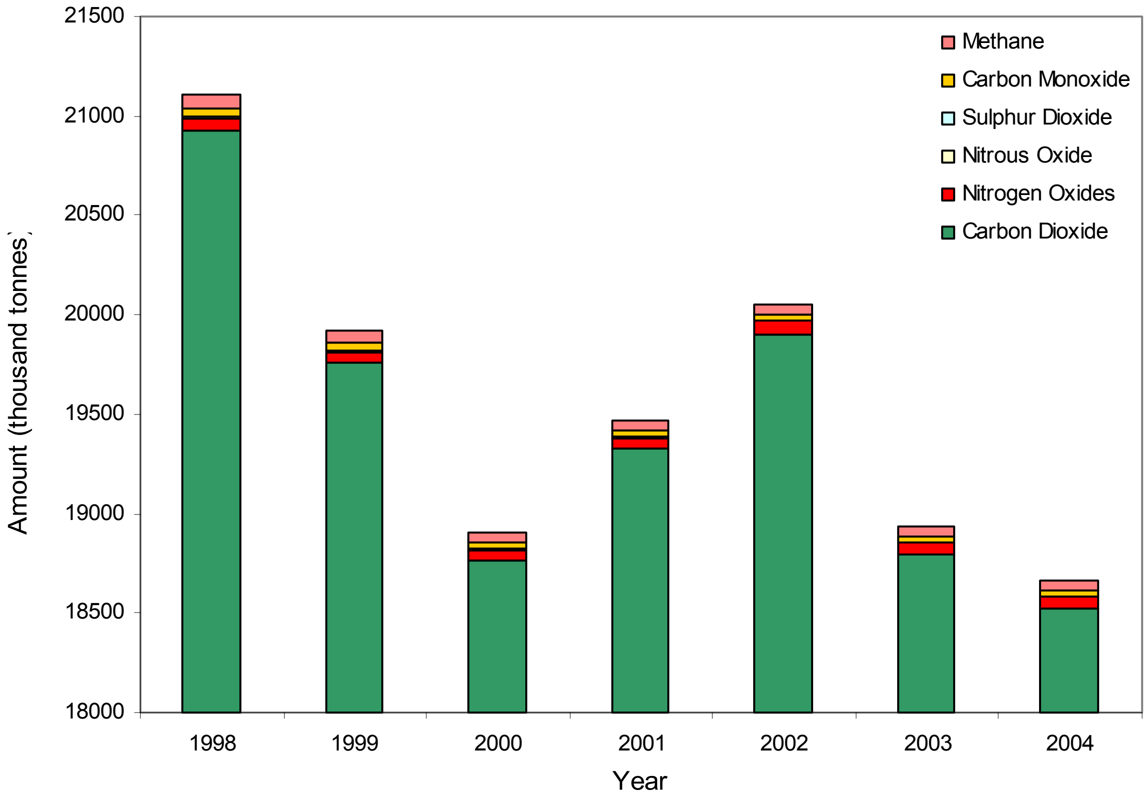
New developments will generally flare in substantial quantities only for well testing, start-up and emergency pressure relief, with "zero routine flaring" now considered a realistic design target for planned developments. Other than start-up flaring, subsea tie-back developments, which are predicted to account for the majority of production from proposed licence areas, will generally have little effect on host platform flaring.

The Environmental Emissions Monitoring System (EEMS) database was established by UKOOA in 1992 to provide a more efficient way of collecting data on behalf of the industry. Atmospheric data from the EEMS system is produced on an annual basis and can be used to show trends in UK offshore oil and gas activity greenhouse gas emissions. Emissions for the period from 1998 are summarised in Figure 9.7.

The dominant greenhouse gas discharged by the offshore oil and gas industry is CO_2, largely from combustion in turbines. Although short-term trends in CO_2 emissions from exploration and production are variable, the overall trend is one of reduction in discharge with emissions in 2004 showing a 1% reduction over 2003 (see Figure 9.7.

The overall decrease in 2003 and 2004 emissions may be attributed to a decline in exploration activity and falling production. However it would be expected that CO_2 emissions would increase due to greater power demands associated with operating mature fields, the use of injection as a method of disposal of produced water and drill cuttings and the potential use of reservoirs for gas storage. UK overall emissions of CO_2 fell by 5.6% between 1990 and 2003 to 572.2 million tonnes (Baggott *et al.* 2005) with offshore E&P activities contributing less than 4 % of this total.

Figure 9.7 – Atmospheric emissions from combined UKCS production and exploration activities



Source: EEMS

9.8.1.3 SEA 6 atmospheric emissions

DTI forecasts of exploration activity in the SEA 6 area, have been used to calculate indicative emissions from SEA 6 exploration drilling activities (Table 9.1). For these calculations, it has been assumed that wells will be drilled using semi-submersible rigs, requiring 16 tonnes of diesel per day to operate and the duration of each well is 40 days. Calculations of atmospheric emissions have been generated using emission factors from the UKOOA Environmental Emissions Monitoring System Guidelines for the Compilation of an Atmospheric Emissions Inventory (2002).

Principal routine operational emissions during drilling would be from combustion products (CO_2, CO, NO_X, SO_2, CH_4 and VOCs) from power generation and engines on the rig, vessels and helicopters. Atmospheric emissions would also be expected from well test operations, however, for the purpose of this assessment no well tests are proposed.

Table 9.1 – Indicative atmospheric emissions resulting from DTI forecast of SEA 6 exploration drilling

	CO_2 (tonnes)	NO_X (tonnes)	N_2O (tonnes)	SO_2 (tonnes)	CO (tonnes)	CH_4 (tonnes)	VOC (tonnes)
Areas 1 to 6[1]	2048	8.6	0.1	2.6	0.6	<0.0	0.2
In Area 7[2]	6144	25.9	0.4	7.7	1.8	0.1	0.6

Notes:

Emissions are based on:

1. *1 well being drilled in each of the Scenario Areas 1 through 6*
2. *3 wells in the Scenario Area 7 (the mature area of the Irish Sea)*

Table 9.2 below uses 2004 data to indicate the effect this additional exploration would have on atmospheric emissions from offshore oil and gas activities.

Table 9.2 – Comparison of atmospheric emissions resulting from additional SEA 6 exploration activity

Year	CO_2 (tonnes)	NO_X (tonnes)	N_2O (tonnes)	SO_2 (tonnes)	CO (tonnes)	CH_4 (tonnes)	VOC (tonnes)
2004 [1]	18,521,571	60,144	1,251	2,938	27375	54,748	66,073
SEA 6 [2]	18,432	77.8	1.3	23.0	5.3	0.2	1.7
SEA 6 %age	0.10%	0.13%	0.10%	0.78%	0.02%	<0.01%	<0.01%

Notes:

1. *Total 2004 offshore emissions from UKCS oil and gas exploration and production activity (EEMS 2005)*
2. *Estimated overall emissions based on 9 wells (1 well being drilled in each of DTI Scenario Areas 1 through 6 and up to 3 wells in DTI Scenario Area 7)).*

As can be seen from the indicative information in the table above, contributions as a result of exploration activities in the SEA 6 area to UKCS exploration emissions would be minimal. Contributions to UK and European atmospheric emissions would be extremely small and would be expected to have, at most, a negligible local and wider environmental impact.

9.8.1.4 Potential effects

Gaseous emissions from the combustion of hydrocarbons and other releases of hydrocarbon gases contribute to atmospheric concentrations of greenhouse gases, acid gases and reduction in local air quality.

Anthropogenic sources of greenhouses gases are implicated in amplifying the natural greenhouse effect resulting in global warming and potential climate change (IPCC 2001). Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) are termed “direct” greenhouse gases as they have a direct effect on radiative forcing within the atmosphere. Other gases including carbon monoxide (CO), volatile organic compounds (VOC), oxides of nitrogen (NO and NO_2) and sulphur dioxide (SO_2) although not significant direct greenhouse gases, are reactive and impact upon the abundance of the direct greenhouse gases through atmospheric chemistry.

Atmospheric acid gases include sulphur dioxide (SO_2) and oxides of nitrogen (NO_X). These gases can be react with water vapour forming acids, to increase the acidity of clouds and rain which can result in vegetation damage, acidification of surface waters and land, and damage to buildings and infrastructure. In addition these gases can transfer directly to surfaces through dry deposition (close to the source) causing similar damage to acid rain (UKTERG 1988). The overall contribution of acid emissions from shipping increased during the 1990s (ICES 2003). Shipping contributes up to 15% of the deposition of these gases in some coastal areas. In the SEA 6 area deposition is lower than that around major shipping routes such as the south western approaches and English Channel. The potential effects of emissions of acid gases are considered to be most important at a regional to local scale.

Reduction in local air quality through inputs of contaminants such as oxides of nitrogen (NO_X), volatile organic compounds (VOCs) and particulates, which contribute to the formation of local tropospheric ozone and photochemical smogs, which in turn can result in human health effects. Ozone is known to impair lung function and NO_X causes irritation of the airways and can be particularly problematic for asthma sufferers (EPAQS 1996).

Hiscock *et al.* (2001) conjecture the potential effects of climate change on seabed wildlife in Scotland and suggest various northern species may decrease or disappear while various southern species may extend their ranges or colonise Scottish waters. The assessment by Hiscock *et al.* (2001) is predicated on climate change resulting in warming air and seawater temperatures and the alternative scenario of cooling through changes in thermohaline circulation (i.e. reductions in the amount of heat translated to northern latitudes by the Gulf Stream and North Atlantic Current) is not addressed. The uncertainties of present models of likely outcomes and effects of climate change are summarised by Rahmstorf (1997). If such cooling were to occur, opposite patterns of species response to those outlined above would be expected to occur.

The absorption of anthropogenic CO_2 in sea water appears to be causing the gradual acidification of sea water. The potential effects of this acidification such as the dissolution of the shells of plankton and coral skeletons have been raised as a concern (Feely *et al.* 2004) and a recent paper by Orr *et al.* (2005) raises the level of concern about potential effects.

9.8.1.5 Conclusions and data gaps

Potential environmental effects of acid gas and greenhouse emissions are, respectively, regional and global in nature. Given the proximity to the coastline of some of the most prospective areas particularly in the Scenario 7 area, local environmental effects of atmospheric emissions (including odour) should be factored into activity permitting.

Significant combustion emissions from flaring are not expected from potential development in the possible SEA 6 licence areas, given the availability of existing gas process and export infrastructure. However, given the slight increase in the amount of gas flared from offshore facilities during 2004 this should be monitored. In view of regulatory controls and commercial considerations, and combustion emissions from power generation are unlikely to represent a major contribution to industry or national totals.

9.9 Waste

In 2004, UKCS offshore oil and gas operations produced around 74,708 tonnes (2003 amount -102,380 tonnes) of waste of which 4,815 tonnes was reused, 16,498 tonnes recycled, 1793 tonnes used in waste to energy and 28,987 tonnes were landfilled (EEMS 2005). The transfer of offshore wastes to shore for treatment and disposal can result in a variety of effects including nuisance, changes in air quality, onshore land use and cumulative effects.

The return of drill muds and cuttings to shore for treatment and disposal is the major change in offshore waste disposals in recent years. In 2004, 34,974 tonnes of treated cuttings were disposed of to landfill which was down slightly from the 2003 quantity of 35,815 tonnes (EEMS 2004 and 2005). It is unlikely that major changes to these volumes would result from licensing in the SEA 6 area as the projected number of exploration and appraisal wells is limited (up to 9) and many or most would be drilled with water based drill fluids. In view of the very limited volumes of material (drilling wastes and general oilfield waste) likely from drilling or operations together with the stringent control of waste disposal activities under IPPC and the Landfill Directive it is believed that any effects on land will be negligible.

Produced water, and drill muds and cuttings may be ground and reinjected to rock formations rather than discharged to sea or returned to land. Interfield transfer of oily cuttings for reinjection is now a permitted activity in UK waters. The reinjection of wastes to source is generally regarded as resulting in positive benefits, such as reduced requirement for landfill space. However, the process of reinjection can be energy intensive and thus result in increased atmospheric emissions from an installation.

The target formation(s) for reinjection of such materials is selected on the basis of geological understanding from previous drilling in the area, with performance monitored over time. Any release to sea or to other unintended rock strata is regarded as an accident and considered later in this section. In addition, in 2004, cuttings cleaning technologies which are capable of reducing oil on cuttings to levels below 1% were trialled on 3 North Sea wells. This may have a future positive impact on quantities of cuttings disposed of on land.

A limited number of developments are projected to result from SEA 6 area licensing. At the end of field life these facilities would be removed with the bulk of materials reused or recycled.

9.10 Accidental events

9.10.1 Introduction

Oil spills are probably the issue of greatest public concern in relation to the offshore oil industry. The risks of large oil spills resulting from E&P are potentially associated with major incidents on production platforms, export (pipeline and tanker loading sources), with the additional potential for loss of well control and subsequent oil blowout. The historical frequency of such events in the UK and Norwegian continental shelves has been very low, with only 4.7% of accidental spills reported from the UKCS (1997-2004) exceeding 1 tonne (see below) and DTI statistics noting two spills >400t and 10 spills >20t since 1991. The total reported oil spilled from installations on the UKCS 1991-2004 was 3051 tonnes. In contrast, major oil spills from shipping, although infrequent, may be large with, for example, the *Sea Empress* incident totalling 72,000 tonnes (see Section 5.5.3).

Other accidental events (with environmental consequences) which are considered include gas releases and chemical spills.

The SEA 6 activity scenarios are low intensity (a forecast maximum of around 12 exploration / appraisal wells, with the socio-economic development scenario involving two new producing fields). This represents a relatively small proportion (<10%) of anticipated UKCS activity and risks of significant accidental events are correspondingly small.

Environmental risk is generally considered as the product of probability (or frequency) and consequence. The environmental consequences of oil (and chemical) spills are associated primarily with seabirds, marine mammals, fisheries and coastal sensitivities; and these sensitivities are considered in the appropriate environment description sections (Sections 5-8) and supporting studies. The sources, frequency, magnitude and potential consequences of hydrocarbons spills are considered below. Much of the information is common to previous SEAs, and is therefore summarised with updates where appropriate.

Specific issues associated with SEA 6 include the location of sensitive coastlines, such as the numerous breeding bird colonies of international conservation importance; the presence of significant concentrations of wintering seabirds and coastal waterbirds; the importance of coastal tourism and recreation; and fisheries generally within the area.

It should be noted that the purpose of SEA risk assessment is not to anticipate the detailed risk assessment and contingency planning which would be required in advance of any development; but to evaluate the overall contribution to risk associated with possible SEA 6-related activity.

9.10.2 Accident scenarios and historic frequency

Previous SEAs have reviewed hydrocarbon spills reported from exploration and production facilities on the UKCS since 1974 under PON1 (formerly under CSON7); annual summaries of which were initially published in the "Brown Book" series, now superseded by on-line data available from the DTI website (www.og.dti.gov.uk).

In 2001, the Operator of the Liverpool Bay Asset (BHP Billiton) requested the renewal of the Production Consent which was due to expire. Given the sensitive location of the operations, both from the point of view of the natural environment and the recreational and economic activities of the area, DTI required that an Environmental Statement (ES) be prepared in support of the application. During the life of the fields a number of incidents have occurred involving oil spillage and odour problems. The ES set out the lessons learned from these incidents and the measures taken to ensure that they are not repeated. The assessment of the Liverpool Bay operations identified a major oil spill as the only source of impact likely to affect these sites, (much larger than those which had occurred in the past which had not lead to damage). Risk assessment indicated that a large oil spill was highly unlikely given the nature of the operations and the management processes but nonetheless an Appropriate Assessment was carried out under the Habitats Regulations to examine this possibility. The conclusion was that the mitigation measures were appropriate and that these combined with the very low likelihood of a major spill conveyed an adequate measure of protection to the sites.

Well control incidents (i.e. "blowouts" involving uncontrolled flow of fluids from a wellbore or wellhead) have been too infrequent on the UKCS for a meaningful analysis of frequency based on historic UKCS data. (The only significant blowouts on the UKCS to date have been from West Vanguard (1985) and Ocean Odyssey (1988), both involving gas.) A review of blowout frequencies cited in UKCS Environmental Statements gives occurrence values in the range 1/ 1000 - 10,000 well-years. These are generally consistent with derived annual frequencies based on worldwide database maintained by SINTEF and Scandpower.

Blowout rates may vary widely, dependent on reservoir characteristics, and the reasons for loss of containment. Qualitative analysis and modelling suggests that high flow rate blowout scenarios (e.g. to surface via drillpipe) will tend to bridge relatively quickly, however, sustained well flow at lower rates can be simulated under some circumstances, which could result in a prolonged release in the absence of intervention.

DTI data indicates that the major types of spill from mobile drilling rigs have been organic phase drilling fluids (and base oil), diesel and crude oil. Topsides couplings, valves and tank overflows; and infield flowlines and risers are the most frequent sources of spills from production operations, with most spills being <1 tonne. A large proportion of reported oil spills in recent years (since about 1990) have resulted from process upsets (leading to excess oil in produced water). Estimated spill risk from UKCS subsea facilities was equivalent to a risk of 0.003 spills / year for an individual facility, with almost all reported spills <5bbl in size.

A total of 24 oil spill incidents were recorded at the Liverpool Bay Asset, within scenario area 7 of the SEA 6 between 1995 and 2000, of which one was significant (see below); three were assigned a nominal quantity of 1 tonne, although actual quantity was probably lower (produced water incidents); and the remainder were in the range 0.0001 – 0.5 tonnes. The significant event was a release of 46 tonnes of crude oil resulting from failure of a breakaway hose coupling. The released oil was dispersed by propeller action, although a small amount (<5 tonnes) of oil beached as tar balls and was subsequently recovered.

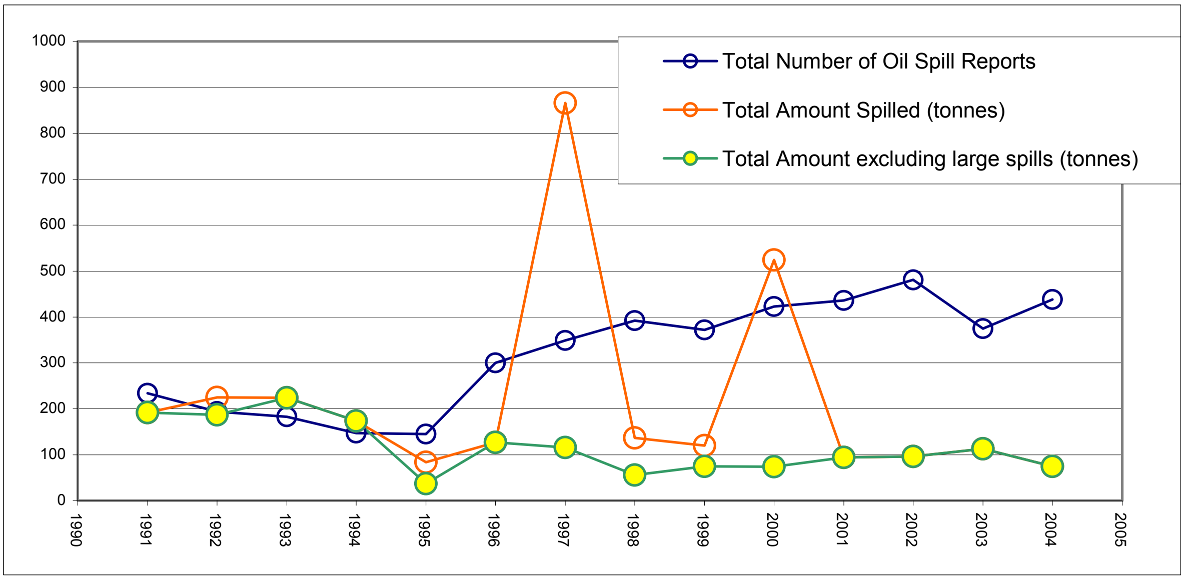
An annual review of reported oil and chemical spills in UK waters – covering both vessels and offshore installations – is made on behalf of the Maritime and Coastguard Agency by the Advisory Committee on Protection of the Sea (e.g. ACOPS 2004). These reviews split the UK Pollution Control Zone into 11 enumeration areas, of which Area 7 (Irish Sea) approximates to the SEA 6 area. In 2003, a total of 10 spills were reported from vessels in the Irish Sea (largest 176 litres) and 5 oil spills from installations (from various sources; largest known spill 200 litres hydraulic oil). (There was also a 150 tonne brine spill from the Douglas platform, which would have negligible environmental effect.) Across the whole review area, 21 discharges of 2 tonnes or more were reported during 2003 including 15 attributed to offshore oil & gas installations (ACOPS 2004). Excluding the large number of spills which occur in port, and a small number from the offshore UKCS enumeration area, 29 vessel-source oil discharges were reported in the open sea during 2003 compared with a mean annual total of 69 vessel-source oil discharges during the previous 4 years.

DTI data for UKCS offshore installations in 2003 include 375 reported spillages, totalling 83 tonnes, Figure 9.8. Over the preceding decade, the reported number of spills has increased, consistent with more rigorous reporting of very minor incidents (e.g. the smallest reported spill in 2003 was 0.0001 litres). However, the underlying trend in spill quantity (excluding specifically-identified large spills) suggests that an annual average around 100 tonnes has been consistently achieved. In comparison, oil discharged with produced water from the UKCS in 2003 totalled 5190 tonnes.

In addition to oil spills, the ACOPS survey identified 48 chemical spills – the majority from installations – including ammonium bisulphate, bentonite, cement and additives, corrosion inhibitors, hydraulic fluids, methanol and triethylene glycol. The volumes of chemical spills ranged from 0.01 litres to 150 tonnes with a median value of 400 litres.

Gas releases from exploration and appraisal drilling can conceivably occur from loss of well control (e.g. gas kick leading to blowout) or from problems during well stem testing; and from production facilities, from failure of the process and export train. The UK Health and Safety Executive's Offshore Safety Division (OSD) records well kicks, involving an unexpected but controlled flow of formation fluids into the wellbore, including "serious" kicks defined as those that posed a safety hazard to personnel on the installation or had the potential to cause a significant safety hazard (Hinton 1999). Between 1988 and 1998, 52 serious kicks were recorded from 3,668 UKCS wells (an occurrence rate of 1.4%), most involving gas and none resulting in significant pollution. The only significant blowouts on the UKCS to date have been from West Vanguard (1985) and Ocean Odyssey (1988), both involving gas.

Figure 9.8 – Reported oil spills on the UKCS, 1991-2004



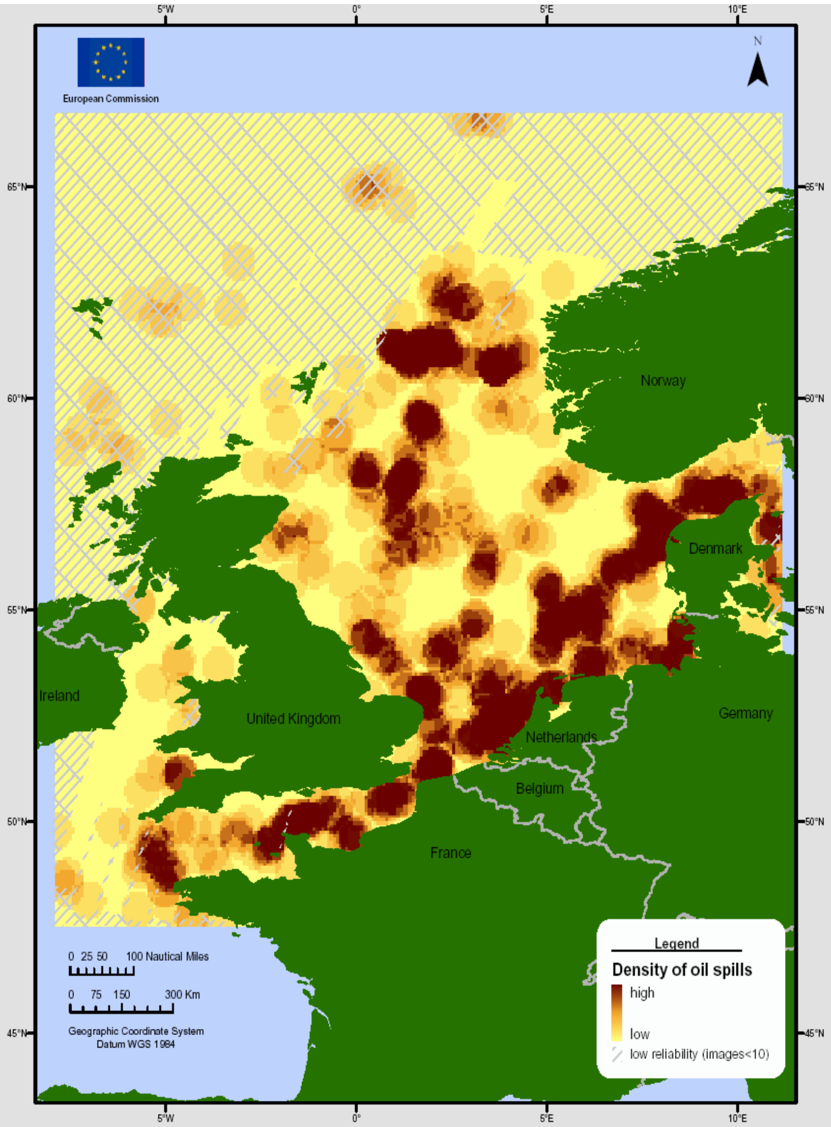
Source: DTI data (http://www.og.dti.gov.uk/)
The 2 large volume oil spills in 1996 and 2000 were from the Captain and Hutton fields

The spatial distribution of oil spills in the North Sea and Irish Sea has been mapped using satellite monitoring. Figure 9.9 shows oil spill density in 2000 derived from the 650 oil spills detected from 2840 Synthetic Aperture Radar (SAR) images. Consistent with the distribution of reported spills, the distribution of observed spills reflects that of production installations in the UK, Norwegian, Danish and Dutch sectors of the North Sea, but also the major shipping routes through the English Channel, approaches to Rotterdam and the Skagerrak.

Historic major spill events from UKCS production facilities include the Claymore pipeline leak, 1986 (estimated 3,000 tonnes), Piper Alpha explosion, 1988 (1,000 tonnes), Captain spill, 1996 (685 tonnes) and Hutton TLP spill, 2000 (450 tonnes). Although potentially significant at a local scale, these volumes are minor in comparison to other anthropogenic sources of oil in the marine environment. For example, in 1995 a total of 11,800 tonnes of oil was discharged by the offshore oil and gas industry to the North Sea, of which 2% originated from accidental spills (OSPAR 2000). Estimates of oil inputs from other sources have not been subject to regular reporting within OSPAR, although the 1993 Quality Status Review estimated a total oil input of 85,000-209,000 tonnes per year to the North Sea, including oil-based drilling fluids, riverine sources, shipping and natural seepage (NSTF 1993).

Globally, the total amount of oil spilled annually depends largely on the incidence of catastrophic spills (Etkin 1999), with less than 300,000 tonnes in most years, but exceptional quantities spilled to sea in 1978 (*Amoco Cadiz*), 1979 (Ixtoc 1 blowout and *Atlantic Empress* tanker spill), 1983 (Nowruz blowout and *Castillo de Bellver* tanker spill) and 1991 (Gulf War). Within the SEA 6 area, the *Sea Empress* spill (1996) resulted in significant bird kill and effects on benthic organisms; apparently, however, without major long-term effects (see Section 5.5.3). As with the *Braer* spill in Shetland, the timing of the spill was fortuitous in limiting environmental effects and prevailing weather conditions assisted in natural dispersion.

Figure 9.9 – Oil spill density in the North Sea in 2000, derived from SAR images



Source: Joint Research Centre - European Commission at http://serac.jrc.it/midiv/

Recent major tanker spills from *Erika* (December 1999, Brittany coast, 19,000 tonnes) and *Prestige* (November 2003, off the Spanish coast, 63,000 tonnes) have both resulted in substantial ecological and economic damage on adjacent coastlines. Heavy oil residues from *Prestige* were distributed to the English Channel coast (ACOPS 2004). In summer 2004 a Spanish-led consortium succeeded in recovering most of the heavy fuel oil cargo remaining in the wreck of *Prestige*, as it lay at a depth of over 3500m off the northwest coast of Galicia. The success of this operation has resulted in calls for more sunken wrecks to be emptied of oil as they are demonstrably now within reach (ITOPF 2005).

9.10.3 Oil spill fate & trajectory

The fate of oil spills to the sea surface is relatively well understood, in contrast to subsea spills in deep water. Following a surface oil spill, there are eight main oil weathering processes: evaporation, dispersion, emulsification, dissolution, oxidation, sedimentation and biodegradation – these are reviewed in SEAs 1, 2 and 3. Coincident with these weathering processes, surface and dispersed oil will be transported as a result of tidal (and other) currents, wind and wave action.

The majority of the anticipated reservoir hydrocarbons in the SEA 6 area are gas, with a limited content of condensate. A dry gas blowout would not result in significant deposition of liquid hydrocarbons to the sea surface, and there have been no large condensate spills on the UKCS resulting from E&A drilling in a comparable reservoir. Although model predictions are that even a large condensate spill would evaporate and disperse relatively quickly, there is little field data to validate this expectation. However, there has been one comparable incident in Canada: the condensate blowout at Shell's Uniacke G-72 well, 16.9km NE of Sable Island (east of Nova Scotia). The Uniacke blowout occurred in February 1984 and continued for 10 days. The gas and condensate aerosol plume was estimated to rise approximately 10m above its point of exit on the rig drilling floor. The slick from the condensate fallout was approximately 300m wide near the source and spread to a width of approximately 500m. It was estimated that between 50 to 70% of the condensate volume evaporated in the air prior to reaching the water although monitoring studies detected condensate up to 10 km from the well, in concentrations generally below 100 ppb. The maximum in-water condensate concentration measured was 1.5 ppm. The slick was observed to physically dissipate once the well was capped and there were no visual observations of a residual slick on over-flights the day after capping (Martec Limited 1984).

Oil spill trajectory modelling can be carried out using commercial models deterministically (i.e. with defined arbitrary metocean conditions, usually “worst case”) or stochastically (i.e. using statistical distributions for wind and current regimes). To support environmental assessments of individual drilling or development projects, modelling is usually carried out for a major crude oil release, corresponding to a blowout, and for smaller diesel or fuel oil releases which are expected to be less persistent.

In order to indicate the likely fate and trajectory of oil spills within the SEA 6 area, two representative cases are summarised below.

Stochastic modelling of representative 22 tonne (100bbl) spills from Liverpool Bay Asset indicates a relatively high – 10-50% - probability of shoreline oiling associated with proximity of these installations to the coast (this modelling does not take account of evaporation and weathering and therefore overestimates beaching probability, BHP Billiton 2001). In view of the very short distances (for example, Lennox is approximately 8km from the closest shore), deterministic times to beach are very short (worst case <4h).

Deterministic trajectory modelling was undertaken for the Dragon appraisal well in the St George’s Channel (block 103/1a, Marathon 2005) using a scenario involving instantaneous loss of the maximum fuel inventory for the proposed rig – 1177 tonnes diesel based on 90% full pontoon tanks – with sustained 30 knot (15.4 m/s) winds in various directions corresponding to the closest land. Deterministic modelling using OSIS v3.1.1 indicated, as expected in view of the location’s proximity to land (34-39km), relatively short times to beach

(12-15h). The modelled proportions of total oil beaching were very low, mainly due to the low persistence of diesel. These are consistent with previous predictions for the Dragon location (and elsewhere) although there have been some changes in model algorithms and oil characterisations, resulting in higher predicted persistence of diesel. The quantities of oil remaining on the sea surface at the end of the model runs undertaken for this ES were negligible; with evaporated volumes in the range 493-498 m^3, and dispersed volumes in the range 412-683 m^3; indicating reasonable consistency of predictions, roughly equal evaporation and dispersion, and no formation of stable emulsion.

Results of stochastic modelling for the Dragon location indicated a low probability (1-5%) of beaching as a result of the 1177 tonnes instantaneous diesel spill, and negligible probability (<1%) as a result of either a 64 tonnes instantaneous kerosene spill (base fluid spill scenario) or 3 m^3 instantaneous diesel spill (bunkering spill scenario). In all cases, stochastic probability contours were elliptical, indicating a higher probability of surface oiling to the north-east (associated with prevailing wind and residual current directions) with a higher probability of oiling in the central St. George's Channel than in adjacent coastal waters. For the smaller spill scenarios, which represent a higher frequency of occurrence, there is therefore a very small probability (<1%) of surface oil affecting the immediate vicinities of major seabird and seal breeding colonies of the Irish and Welsh coasts. For the larger spill scenario, which has an extremely low probability of occurrence, there is a low probability (1-5%) of local effects at breeding colonies.

9.10.4 Ecological effects

The most vulnerable components of the ecosystem to oil spills in offshore and coastal environments are seabirds and marine mammals, due to their close association with the sea surface. These sensitivities are discussed below. Benthic habitats and species may also be sensitive to deposition of oil associated with sedimentation. Following the *Sea Empress* spill, mortality of intertidal organisms occurred as a result of direct oiling; while subtidal communities were affected by dissolved hydrocarbons (SEEC 1998). Disruption of intertidal communities over a range of timescales has been observed following many major oil spills; typically with disturbance of the balance between algal populations, grazing species and predators on rocky shores. Effects on sediment communities are typically associated with deoxygenation and organic enrichment. In both cases, the effects of chemical dispersants may be more severe than those of oil.

Direct mortality of seabirds in the event of oil spill is the most widely perceived risk associated with the proposed licensing and subsequent activities. Spills affecting waters near major colonies during the breeding season could be catastrophic (Tasker 1997). Seabirds are affected by oil pollution in several ways, including oiling of plumage and loss of insulating properties, and ingestion of oil during preening causing liver and kidney damage (Furness and Monaghan 1987).

Census of seabird colonies in south west Wales following the *Sea Empress* spill concluded that only guillemot and razorbill populations were impacted by the spill (Baines & Earl 1998). The *Sea Empress* spill occurred in February, when seabird numbers at colonies were relatively low, but the density of wintering birds including common scoter was high. Some species, particularly puffins, Manx shearwaters and storm petrels, had not returned to the area to breed and so avoided significant impact. Around 7,000 oiled birds were washed ashore following the spill, although it is likely that the total number of birds killed was several times higher than this (SEEEC 1998). Examination of seabird corpses suggested that most died directly from oil contamination rather than, for example, food chain effects. Over 90% of the oiled birds were of three species – common scoter, guillemot and razorbill. Counts of the breeding populations confirmed the impact on guillemots and razorbills. There were 13% fewer guillemots and 7% fewer razorbills counted at breeding colonies in the area in 1996 compared with 1995, while numbers for both species increased at nearby colonies. By the 1997 breeding season, numbers had recovered significantly.

Offshore vulnerability to surface pollution in the SEA 6 area was reviewed in Section 6.7, with very high in some blocks of Quadrants 111 and 108 (Scenario area 3), 110 (Scenario area 5), 105, 103 and 107 (Scenario area 1) and high in some blocks of Quadrants 111, 108 (Scenario area 3), 109 (Scenario areas 2, 3 and 6), 110 (Scenario areas 5 and 7), 105 (Scenario areas 1 and 2) and 107 (Scenario areas 1 and 2). All of the other blocks within the SEA 6 area are either moderate or low. Much of the seabird vulnerability is associated with proximity of breeding colonies and post-breeding dispersal of auks and is therefore seasonal; with vulnerability very high for more than six months only in some blocks of Quadrants 111 and 108 (Scenario area 3) and Quadrant 103 (southern part of Scenario area 1). The remainder of the blocks have very high vulnerability for less than 6 months per year.

The specific vulnerability of coastal waterbirds (including divers, grebes and seaduck) has not been quantified with a methodology comparable to the seabird OVI, although these species are included in calculations of OVI. Analysis of seasonal importance of sub-areas of SEA 6, in terms of abundance of divers, grebes and seaduck, was carried out as part of supporting studies for SEA 6 (Barton & Pollock 2005). In general, waterbird sensitivity is highly seasonal and is predominantly associated with wintering species in the SEA 6 area.

The *Sea Empress* oil spill had a significant impact on the wintering population of common scoters in Carmarthen Bay and 3,500 are known to have died. 1997 counts showed about 10,000 fewer birds visiting Carmarthen Bay than the 1996 peak (though factors other than the oil spill may have been involved as numbers generally fluctuate from year to year).

Oil spill risks to marine mammals have been reviewed by Hammond *et al*. 2005. Direct mortality of seals as a result of contaminant exposure associated with major oil spills has been reported, e.g. following the Exxon Valdez oil spill in Alaska in 1989. Additional pup mortality was reported in areas of heavy oil contamination compared to unoiled areas.

More generally, marine mammals are less vulnerable than seabirds to fouling by oil, but they are at risk from hydrocarbons and other chemicals that may evaporate from the surface of an oil slick at sea within the first few days. Symptoms from acute exposure to volatile hydrocarbons include irritation to the eyes and lungs, lethargy, poor coordination and difficulty with breathing.

Grey and harbour seals come ashore regularly throughout the year between foraging trips and additionally spend significantly more time ashore during the moulting period (February-April in grey seals; August-September in harbour seals) and particularly the pupping season (see Section 6.8). Animals most at risk from oil coming ashore on seal haul-out sites and breeding colonies are neonatal pups, which are therefore more susceptible than adults to external oil contamination. In Wales, grey seal pups have been born in all months of the year but there is a peak in September. Harbour seals, which are generally uncommon within the SEA 6 area, pup in June-July.

Intertidal habitats and species are vulnerable to surface oil pollution, or to windblown oil in the case of maritime habitats (e.g. dune systems). The vulnerability of different shore types to oil pollution is largely dependent on substrate and wave exposure, and is reviewed in relation to SEA 6 coastlines in Section 5.29. Sensitivity mapping of the English and Welsh coasts has been undertaken by Operators of oil & gas facilities in the SEA 6 area.

The ecological effects of chemical spills are dependent on the physical properties and toxicity of the chemical involved. Since chemical selection and use on offshore facilities is tightly regulated (Section 3.3) and the majority of chemicals are in low risk categories, the potential risk is considered to be low (e.g. in contrast to bulk shipping of hazardous chemicals).

Minor gas releases subsea would be expected to result in significant dissolution in the water column, with a proportion of gas released to atmosphere. Major releases, and all releases direct to atmosphere, will contribute to local air quality effects and to global greenhouse gas concentrations. The relative contribution of all foreseeable releases is minor.

9.10.5 Socio-economic effects

In addition to fishing, coastal industry and activities in adjacent areas to the SEA 6 area include tourism and recreation. Both are of considerable economic importance to local economies and are vulnerable to the effects of major oil spills. Impact on the tourism and amenity "appeal" of coastal areas in the event of a major oil spill, primarily in terms of tourist numbers, would be influenced primarily by the extent, duration and tone of media reporting, and by public perception of the severity of the event. These factors cannot be reliably predicted.

Following the *Sea Empress* spill, as a precautionary measure, a ban (i.e. Exclusion Orders issued under the Food and Environmental Protection Act 1985) on all fishing and the collection of edible plants and seaweeds was imposed over an area stretching from St David's Head to the Gower (SEEEC 1998). Fishing for salmon and sea trout was also banned in the rivers flowing into this area. Samples of various species of fish, shellfish and crustaceans were analysed for oil content over the subsequent months, and the closure orders were lifted in stages as analysis showed that oil concentrations in different classes of organism had returned to background levels. All restrictions were removed by 12 September 1997. However, following the issue and subsequent lifting of these orders, there was widespread confusion both in the fishing community and amongst the general public about the basis of these orders SEEEC 1998).

Impact on the recreational, tourism and amenity appeal of the Welsh, NW English and Irish coasts, including the "hotspots" of Pembroke and Wexford, in the event of a major oil spill would be influenced both by the severity of oiling and by the extent, duration and tone of media reporting and resulting public perception of the severity of the event. Although the *Sea Empress* spill was more severe than any conceivable incident associated with the proposed SEA 6 activities, the economic impact on tourism was relatively minor (SEEEC 1998). Analysis of the impact on tourism throughout Pembrokeshire suggested a downturn of about £2 million in the commercial service sector in 1996 set against an estimated £160 million contributed by tourists to the economy in 1995. Nevertheless, despite satisfaction with the quality of the environment by those visiting the area, there was evidence from further questionnaires that for one in five who actually considered visiting Pembrokeshire in 1996, the *Sea Empress* spill was significant in leading to rejection.

Major gas releases and chemical spills both have some potential for significant effects in terms of short-term safety issues and longer-term socio-economic effects. As noted above, chemicals used in offshore E&P are generally in low risk categories, and the socio-economic effects are generally similar in nature, but of lower severity, to oil spill. Potential safety issues of gas releases include explosion and (for subsea releases) loss of buoyancy for vessels and floating installations.

9.10.6 Oil spill response preparedness

Spill prevention and mitigation measures are implemented for offshore exploration and production through The Offshore Petroleum Production and Pipe-lines (Assessment of Environmental Effects) Regulations 1999 and The Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation) Regulations 1998. The required measures include spill prevention and containment measures, risk assessment and contingency planning.

Offshore, primary responsibility for oil spill response lies with the relevant Operator, although the Secretary of State's Representative (SOSREP) may intervene if necessary. The Maritime and Coastguard Agency (MCA) is responsible for a National Contingency Plan in consultation with other relevant departments, agencies and stakeholders, a draft revision of which was issued in June 2005 for comment. MCA maintains four Emergency Towing Vessels (ETVs) including one in the South-West Approaches, which remain on standby at sea. In addition, the MCA maintains a contractual arrangement for provision of aerial spraying and surveillance, with aircraft based at Coventry and Inverness. Within two days, aircraft can deliver sufficient dispersant to treat a 16,000 tonne spill within 50 miles of the coast anywhere around the UK (National Audit Office 2002). The DTI is a partner in this arrangement and undertakes regular aerial surveillance of offshore installations. MCA holds 1,400 tonnes of dispersant stockpiled in 14 locations around the UK (including Milford Haven), in addition to counter-pollution equipment (booms, absorbents etc.) which can be mobilised within 2-12 hours depending on incident location.

Similar response capabilities, providing a tiered response capability, must be available to Operators prior to commencing drilling or production activities. These provisions are made under various long-term commercial contracts with specialist contractors, supplemented where necessary (e.g. for remote locations) with additional stockpiles. Site-specific Oil Spill Contingency Plans must also be submitted to DTI for approval prior to operations. Additional conditions can be imposed by DTI, through block-specific licence conditions (i.e. "Essential Elements").

Minimum beaching times from some parts of the SEA 6 area are short and may not provide sufficient time for at sea response measures. Coastal oil spill risks would therefore be a key issue in assessment and risk management of proposed exploration and developments within parts of the SEA 6 area.

Coastal oil spill contingency response arrangements are currently the responsibility of local authorities. Following previous licence Rounds, Operators of nearshore blocks have consulted and co-operated with local authorities and conservation agencies on contingency planning (e.g. for the Liverpool Bay development), and in some cases have developed Coastal Protection Plans, and trained local authority personnel and provided response equipment.

9.10.7 Conclusions & data gaps

The environmental risks of accidental events associated with proposed activities in the SEA 6 area are qualitatively similar to those of previous and ongoing activities, and mitigation in the form of risk assessment and contingency arrangements are well established.

Project specific risk is highly associated with reservoir fluid type (i.e. heavy oil >>condensate>gas) and distance from sensitive coastal habitats and locations. The likelihood of E&P activity is highest and distances to shore are lowest from the developed areas in scenario area 7 (around the existing Liverpool Bay and Morecambe assets), and the adjacent coastline includes highly vulnerable bird populations and sensitive sedimentary and saltmarsh habitats. However, the Solway area (scenario area 4) is also highly sensitive; and ecological, recreational and amenity quality of the Irish and Welsh coastlines adjacent to scenario areas 1, 2, 3 and 6 is sufficiently high that there are no clear variations in overall sensitivity within the SEA 6 area.

In some cases, there is strong seasonality in sensitivities of individual scenario areas – in particular in relation to bird populations. Existing regulatory controls emphasise the risk management and contingency planning aspects of environmental management, including the timing of operations; and additional controls at an SEA level are not considered to be necessary.

Data gaps identified by the SEA 6 process in relation to accidental events include quantification of the vulnerability of coastal waterbird populations in scenario areas 5 and 7. However, lack this detailed data does not compromise the SEA process significantly, and a precautionary assessment of proposed activities (at a project-specific EA level) is recommended.

9.11 Potential socio-economic implications

9.11.1 Context

UK natural gas production in 2002 was 5.7% less than peak production in 2000. There has also been a substantial increase in the UK demand for natural gas, up 37% between 1993 and 2002. Demand for gas is projected to rise at an annual rate of 1.7% until 2012/13. Despite the decline in production and rise in consumption, the UK continued to be a net-exporter of natural gas in 2002, a status it has held since 1997. However, due to the decline in production from mature natural gas fields and limited opportunities to find new, significant prospects, the UK is expected to become a natural gas importer within the next few years.

The volume of imports is set to drastically increase during the next ten to fifteen years. In the next twenty years, as production from the UK Continental Shelf (UKCS) declines and the UK becomes more dependent on imported gas, there will be an increasing need for new gas supply sources as well as investment in infrastructure projects to meet both annual demand and the seasonal and daily swings in demand. There are a number of potential market options:

- additional import connections from Norway, direct to shore or via existing UKCS infrastructure;
- liquefied natural gas (LNG) terminals to import gas from worldwide sources;
- more interconnection with Europe to import gas from the Netherlands, Norway and beyond;
- pipeline upgrades to existing interconnectors to increase import capacity;
- gas storage, both onshore and offshore, to provide additional seasonal and daily swing capacity and to replace capacity which will be lost with the decline in UKCS swing capacity.

Security of gas and oil supplies is one of the main economic issues now facing the UK energy sector. Since 1997, the UK has been a net exporter of gas, mainly via the Bacton–Zeebrugge interconnector. Given the projected decline in UKCS production, the UK may revert to being a net importer of gas on an annual basis by 2005, with a large and growing import requirement by the end of this decade and beyond. Although reliance on gas imports is not a new feature of the UK energy supply mix, the extent of previous dependence - imports met as much as 25 per cent of UK demand in the 1980s - was not on the scale now anticipated (perhaps 40 per cent by 2010 and 80 per cent or more by 2020) (Joint Energy Security of Supply Working Group (JESS) report 2004).

A number of projects are nearing completion or underway to expand and diversify the UK's gas supplies including development of greater storage facilities, the Langeled pipeline to import gas from Norway, two new Liquefied Natural Gas (LNG) import terminals at Milford Haven, and a new pipeline from the Netherlands (Secretary of State's (SoS) First Report to Parliament on Security of Gas and Electricity Supply in Great Britain 2005). By winter 2007/08, these new facilities could potentially increase the UK's annual gas import capacity to between 52 and 119bcm, and will be sufficient to meet the supply gap resulting from the decline in UK gas production (Parliamentary Office of Science and Technology 2004).

North Sea oil output peaked at about 2.9 million barrels per day in 1999 and, having already fallen by one sixth, is predicted to fall to only 1.6 million barrels per day by 2007. It has been estimated that by 2020 the UK could be dependent on imported energy for 80% of its needs.

Gross production of crude oil and NGLs in 2003 was 106 million tonnes, a decline of 8½ per cent on 2002 and 23 per cent lower than the peak production level of 137 million tonnes in 1999. Almost three-quarters of the United Kingdom's primary oil production in 2003 was exported and imported crude oil accounted for 64 per cent of UK requirements.

One reason for this decline in production is the maturity of the UKCS fields. Other reasons include smaller fields being brought into production and the application of new technologies which can result in particular fields being exhausted at a quicker rate. It is also becoming costlier to extract as they are located in more remote regions and contain smaller quantities of oil.

The UK Government is also working with industry via a number of initiatives to realise the remaining UKCS oil and gas potential. For example, promote licences have encouraged a number of new entrants to the UKCS whilst the 'Fallow' initiative has been introduced to prompt licensees with undeveloped discoveries or undrilled prospects to engage with other parties interested in taking those opportunities forward (SoS 2005). These initiatives have been described previously in Section 10.6.1 of the SEA 5 Environment Report.

The socio-economic information and analysis presented in this section comes largely from two technical reports commissioned as part of the SEA 6 process - *SEA 6: Economic and Social Baseline Study* (Mackay Consultants 2005a) and *The Potential Socio-economic Implications of Licensing the SEA 6 Area* (Mackay Consultants 2005b). The following provides a summary of the key aspects of these reports, the reports themselves should be referred to for more detailed information.

9.11.2 SEA 6 area overview

Coastal industry and activities

Coastal region (Relevant Scenario areas)	Socio-economic overview
England (4, 5, 7)	Cumbria largely rural with Lancashire and Merseyside more industrial and heavily populated. Tourism important along west coast particularly in Cumbria. Number of important coastal resorts (e.g. Blackpool). Fishing important industry in Cumbria. Morecambe Bay cockle fishery of considerable economic importance. Number of important ports – Liverpool, Heysham and Fleetwood. Gas terminal for Morecambe Bay fields located at Barrow-in-Furness. Heysham in Lancashire is main supply base for Morecambe and Liverpool Bay oil and gas fields. Number of offshore wind energy projects under development – Robin Rigg in Solway Firth (60 turbines), Barrow project off Cumbria (30 turbines) and Shell Flats off Lancashire coast. Two possible Round 2 wind farms - Walney and West Duddon. Proposed Ormonde joint offshore gas/wind farm development.
Wales (1, 2, 3, 5, 6)	Coastal region rural with industry centred on Flintshire and Milford Haven. Few commercial ports – Milford Haven, Holyhead, Fishguard and Mostyn. Fishing locally important although nationally important mussel fisheries in Menai Strait and Conway Bay. Important coastal resorts on the north coast and tourism also important along west coast. Sailing popular with numerous coastal marinas. Gas terminal for Liverpool Bay fields located at Point of Ayr on Flintshire coast. Number of offshore wind energy projects completed or under development – North Hoyle off the north coast (30 turbines, completed 2003), Rhyl Flats (Round 1 site close to North Hoyle) and Gwynt y Môr (Round 2 site) have yet to be developed.
Northern Ireland (3)	Coastal region largely rural with industry and population centred on the important ports of Belfast, Derry, Larne and Warrenpoint. Fishing important with main ports at Kilkeel, Ardglass and Portavogie. Tourism has become increasingly important with the sea loughs popular for sailing. Very little involvement in offshore oil and gas industry.
South west Scotland (3, 4)	Coastal region largely rural with fishing and tourism important industries. Main commercial ports - Stranraer, Cairnryan, Ayr/Troon and on the Clyde. Very little involvement in offshore oil and gas industry. Number of gas pipelines make landfall in region. Robin Rigg offshore windfarm under development in Solway Firth.
Isle of Man	Main economic sectors are financial services and tourism. Ferry services from Douglas to Belfast, Dublin, Fleetwood, Heysham and Liverpool. Sailing popular in surrounding waters.

Source: Mackay Consultants (2005a & b).

Existing offshore oil and gas infrastructure and activities

Existing offshore oil and gas infrastructure and activities within the SEA 6 area are described in some detail in the socio-economic technical reports (Mackay Consultants 2005a & b) and the *SEA 6: Other Users* report (Luddington & Moore 2005).

Offshore oil and gas activity is on a smaller scale than in the North Sea but it is nevertheless a significant activity in the SEA 6 area. There are currently twelve oil and gas fields in production, with a few others expected to be developed in the near future (Mackay Consultants 2005). These fields are in two main groups – Morecambe Bay (producing gas and some condensate, operated by Centrica Energy) and Liverpool Bay (producing oil and gas, operated by BHP Billiton Petroleum).

Morecambe Bay

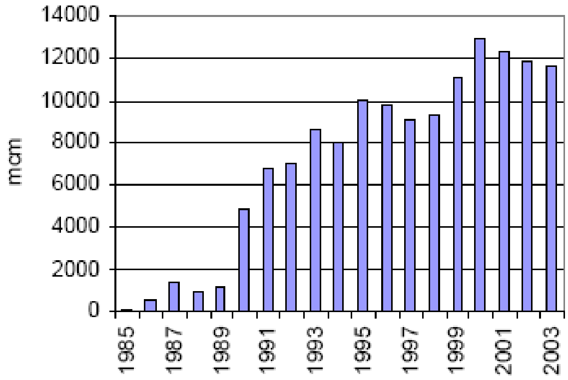


Figure 9.10 – Gas production from Morecambe Bay fields

Note: Values in million cubic metres (mcm)
Source: DTI website – http://www.og.dti.gov.uk

Gas production from the Morecambe Bay fields began in 1985 and peaked at 12.9bcm (billion cubic metres) in 2000. It has fallen slightly since and the 2003 total was just under 11.7bcm. The status of the Morecambe Bay fields currently under production are highlighted in Table 9.3

Table 9.3 – Status of Morecambe Bay fields

Field	Onstream	Original recoverable reserves (bcm)	Remaining reserves (% of original)
South Morecambe	1985	144.4	27 (20)
North Morecambe	1994	27.9	2 (8)
Dalton	1999	2.9	2 (69)
Millom (& Millom West)	1999 (& 2000)	6.1	2 (33)
Bains	2002	1.4	0.5 (36)
Calder	2004	-	-

Note: Values in billion cubic metres (bcm)
Source: Mackay Consultants (2005b).

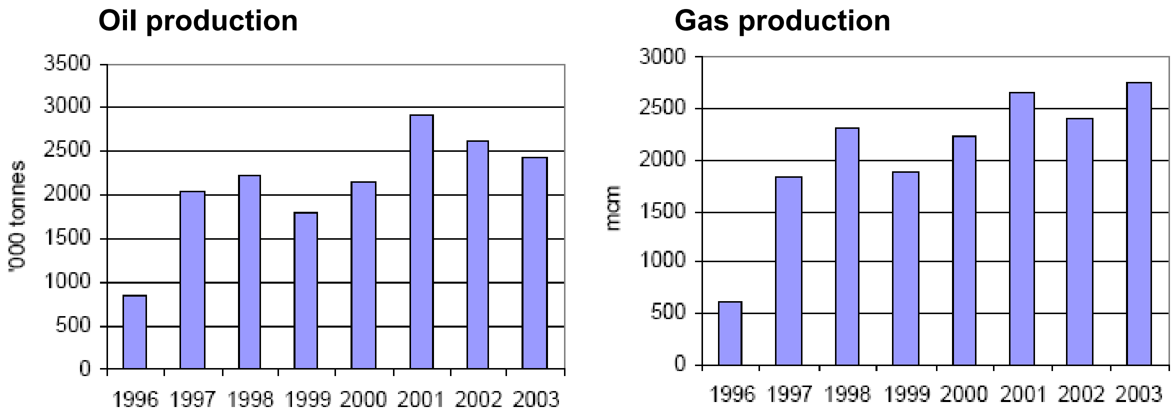
The Rivers Project within the Morecambe Bay area represents the main offshore development currently underway in the area. The development will involve up to five small gas fields (Calder, Darwen, Crossans, Hodder and Asland) estimated to contain more than 7.1bcm of gas. First gas from the Calder field was in October 2004 with the Darwen and Crossan fields expected to be tied in by subsea completions in 2007. There are currently no development plans for the Hodder and Asland discoveries (Mackay Consultants 2005b).

Liverpool Bay

The Liverpool Bay fields produce both oil and gas. Douglas, Douglas West and Lennox are oil fields, with associated gas production from Lennox and the three Hamilton fields produce gas (see Table 9.4 for details of the status of these fields).

Oil and gas production from the Liverpool Bay fields began in 1996 with oil production reaching a peak of 2.9 million tonnes in 2001. Gas production has risen to just over 2.7 billion cubic metres in 2003 (Figure 9.11).

Figure 9.11 - Oil and gas production from Liverpool Bay



Note: Values in '000 tonnes of oil and million cubic metres (mcm) of gas.
Source: DTI website – http://www.og.dti.gov.uk

Table 9.4 – Status of the Liverpool Bay fields

Field	Onstream	Original recoverable reserves	Remaining reserves (% of original)
Hamilton North	1995	5.3bcm	0.3bcm* (6)
Douglas	1996	13.3mt	4.6mt (35)
Lennox	1996	10.1mt 10.3bcm	0.1mt* (1) -
Hamilton	1997	14.3bcm	1.3bcm* (9)
Hamilton East	2001	-	-
Douglas West	2003	-	-

*Note: Values in billion cubic metres (bcm) of gas and million tonnes (mt) of oil. *Reserves may be upgraded.*
Source: Mackay Consultants (2005b).

9.11.3 DTI scenarios

The DTI scenarios of predicted activity arising from SEA 6 licensing are described in Section 4.3. For the purposes of socio-economic analysis, Mackay Consultants (2005b) converted these into pessimistic and optimistic scenarios.

Pessimistic scenario

This scenario assumes the development of two small fields of similar size - one oil and one gas. The oil field would produce up to 5,000 barrels per day (bpd) from recoverable reserves of 1 million tonnes (or 7.5 million barrels). The gas field would produce up to 25 million cubic feet per day (mcfd) from recoverable reserves of 10 billion cubic metres (350 billion cubic feet). Both fields would have a five year production life, with three years at peak output and two years at 50% of that level.

The estimated development cost of each of these two fields is £50 million. Both would be single well subsea tiebacks to existing production facilities. In addition, two exploration wells would be drilled.

Optimistic scenario

In addition to the pessimistic scenario developments, there would be two larger field developments - one oil and one gas. The oil field would produce up to 50,000 barrels per day from recoverable reserves of 127.5 million barrels (17.0 million tonnes), with a ten year lifetime. The gas field would produce up to 250 million cubic feet per day from recoverable reserves of 3,500 billion cubic feet (100 billion cubic metres), also with a ten year lifetime.

The estimated development cost of each of these two fields is £250 million. Both would require new production platforms, although the gas field may be able to use one of the existing gas pipelines to an onshore terminal. In addition, ten exploration and appraisal wells would be drilled.

9.11.4 Potential socio-economic effects

Implications for oil and gas production

Oil production

UKCS oil production seems to have peaked in 1999 at 124.9 million tonnes, equivalent to 2.6 million barrels per day with general agreement that the future is one of slow decline. The rate of decline is difficult to forecast but Mackay Consultants (2005b) have assumed an annual average decline of -5% from 2005 onwards.

SEA 6 production is assumed to start in 2011 by which time UKCS production would have fallen to 60.8mt, down –42% on the 2002 level. Under the pessimistic scenario total production will continue to decline and SEA 6 production would have a negligible impact. For example, 2014 production of 52.4mt would be only +0.6% higher than the Rest of UKCS total.

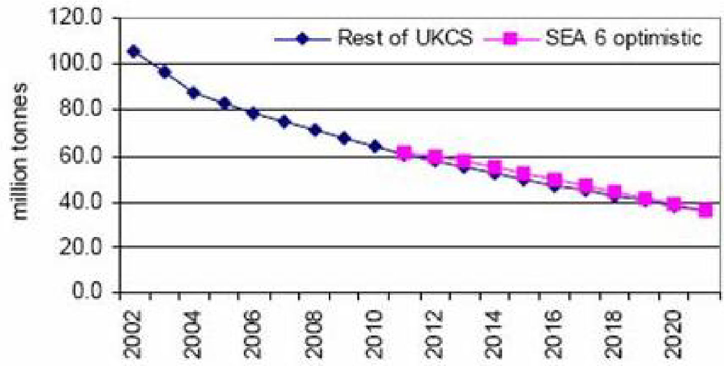


Figure 9.12 – Forecasts of UKCS oil production

Source: Mackay Consultants (2005b).

Under the optimistic scenario, the rate of decline would slow down (Figure 9.12). For example, the 2014 production is +5.4% higher than it would be without SEA 6 output.

Gas production

Gas production is much more important than oil in the SEA 6 area at the present time. The Morecambe Bay fields currently account for about 12% of UKCS gas production and the

Liverpool Bay fields about 3%, giving a combined total of about 15%. That compares with a 2.5% share of UKCS oil production.

The general expectation is that offshore gas output will also decline slowly in the future. Mackay Consultants (2005b) have assumed UKCS gas output will decline at an annual average of –3.0% to 2010 and by –5.0% after that year.

SEA 6 gas production would begin in 2011. Under the pessimistic scenario there would be a very small increase in output with a negligible impact on UKCS production. For example, the difference in 2014 would be just +0.4% higher.

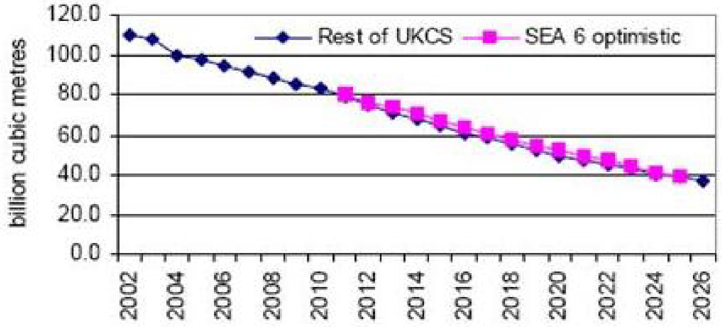


Figure 9.13 – Forecasts of UKCS gas production

Source: Mackay Consultants (2005b).

Under the optimistic scenario SEA 6 output is substantially higher and would help slow the rate of decline (Figure 9.13). For example, total output in 2022 would be +5.6% higher.

Implications for existing facilities

Gas production from the Morecambe Bay fields peaked in 2000 and has declined slowly since then. The Rivers group of fields are currently being developed as subsea tiebacks to the existing facilities and will help to slow down the production decline from the existing fields but are unlikely to reverse that trend. Thus there will likely be increasing spare capacity in the Morecambe Bay facilities, including the pipelines and terminal complex.

Gas production from the Liverpool Bay fields is on a much smaller scale. It has increased over the last few years although is expected to begin to decline soon and thus there will also be spare capacity in the production facilities, pipeline and Point of Ayr processing terminal. Oil production reached a peak of 2.9 million tonnes, equivalent to about 60,000 barrels per day, in 2001 and has fallen in each year since then. The Liverpool Bay project could end by about 2014, unless there are new discoveries which could use the facilities (Mackay Consultants 2005b).

Implications for employment

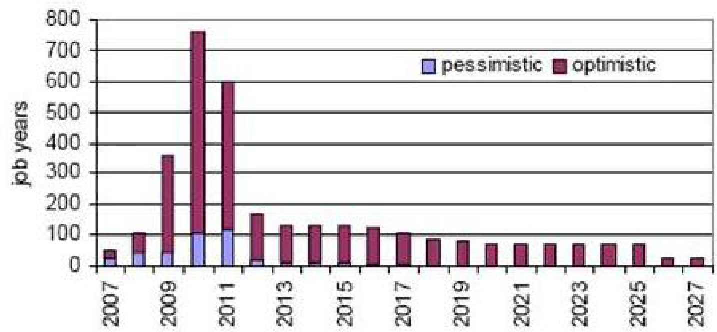


Figure 9.14 – SEA 6 potential employment

Note: Values are in job years.
Source: Mackay Consultants (2005b).

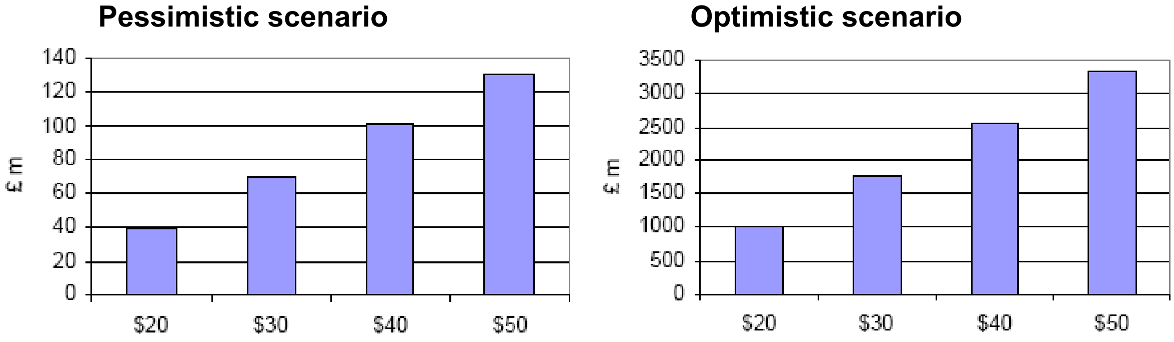
The total employment, year by year, is shown in Figure 9.14. For the optimistic scenario the overall total is estimated at 2,905 person years, with a peak of 650 in 2010. For the pessimistic scenario the overall total is 405 person years, with a peak of 120 in 2011.

Given the earlier forecasts of declining production on the UKCS, it would be reasonable to expect employment also to decline in the future. In that context the employment created by SEA 6 activity would help to slow down the rate of decline. Any new fields and production in the SEA 6 area should help to extend the lives of existing facilities such as the gas terminals at Barrow and Point of Ayr, and therefore help to maintain employment there.

Implications for tax revenues

Over the last seven years North Sea oil prices have fluctuated between $9 and $55 per barrel. They have been relatively high for the last few years and at May 2005 Brent crude was selling at about $50. Mackay Consultants (2005) used a range of prices from $20 to $50 per barrel to estimate tax payments for the different SEA 6 scenarios (Figure 9.15). To facilitate analysis, they assumed that oil and gas prices were identical, in terms of their energy equivalence.

Figure 9.15 – SEA 6 tax payments (£) according to cost of a barrel of oil ($)



Under the pessimistic scenario the tax revenues generated range from £39.5 million at $20 per barrel to £130.7 million at $50 per barrel. These are very small sums but not negligible. Under the optimistic scenario the range is from £1,003 million to £3,318 million.

According to the DTI website (http://www.og.dti.gov.uk), UK oil and gas production contributed £4,353 million in taxes and royalties in the 2003-4 financial year. Tax revenues will almost certainly decline over the next few years, as a consequence of falling oil and gas production (although oil prices and the exchange rate will also be important factors) and thus tax revenues from SEA 6 fields in the optimistic scenario could be very significant.

Social implications

As with the economic impacts, the social impacts are likely to be incremental or marginal, rather than absolute. Some of the SEA 6 area has been involved with the oil and gas industry for up to 20 years, through the Morecambe Bay and Liverpool Bay developments. Thus people living in towns such as Barrow and Heysham are accustomed to the industry, so for them there are unlikely to be any significant new social impacts, either positive or negative.

That would not be the case if there were oil/gas-related developments in other parts of the SEA 6 area, such as West Wales or Northern Ireland, where there has been no such activity. Much of the area is rural so new industrial developments could have significant social impacts there. However, the prospects for new developments away from the existing Morecambe Bay and Liverpool Bay complexes appear to be very small.

Oil and gas production from the existing fields is forecast to decline significantly over the next few years. Any new SEA 6 developments could therefore help to retain employment, skills and population in areas like Barrow and Heysham.

Income levels in the SEA 6 area are generally well below the UK average, although there are a few notable exceptions. This factor and the population decline indicate a need for more economic development. In that context new oil and gas activity in the SEA 6 area could be both socially and economically beneficial.

9.12 Cumulative effects

As noted above, the SEA Directive (footnote to Annex I) requires *inter alia* that secondary, cumulative and synergistic effects should be considered. Stakeholder consultation has confirmed the importance of cumulative effects within the overall process. The approach adopted for assessment of cumulative effects within the DTI SEA process reflects guidance from a range of sources within the UK, EU and internationally. Guidelines on the range of techniques for assessing cumulative impacts (and indirect impacts & impact interactions) have been prepared on behalf of the EU, although this was primarily targeted at Environmental Impacts Assessments and Integrated Pollution Prevention and Control. A practical guide to the SEA Directive has recently been produced by the Office of the Deputy Prime Minister (ODPM 2005). Other background literature utilised included best practice guidelines from other countries and industries and published work including Bain *et al*. 1986, Canter & Kamath 1995, Irwin & Rodes 1992, Lane & Wallace 1998, Vestal *et al*. 1995, Cumulative Effects Assessment under the U.S. National Environmental Policy Act (NEPA website), and Canadian Environmental Assessment Act (Canadian Environmental Assessment Agency website).

Secondary, cumulative and synergistic effects are not defined by the SEA Directive, and a range of definitions have been used. ODPM (2005) notes that the terms are, to some extent, not mutually exclusive and that often the term cumulative effects is taken to include secondary and synergistic effects. An addition term, incremental effects, has been used by previous DTI SEAs to distinguish those effects which result from activities which may be carried out under the proposed licensing; together with activities carried out under previous licensing.

Secondary effects comprise indirect effects which do not occur as a direct result of the proposed activities, but as a result of complex causal pathway (which may not be predictable).

Incremental effects have been considered within the SEA process as effects from licensing E&P activities, which have the potential to act additively with those from other oil and gas activity, including:

- forecast activity in newly licensed areas
- new exploration and production activities in existing licensed areas
- existing production activities
- forecast decommissioning activities
- “legacy” effects of previous E&P activities, post-decommissioning (e.g. unrecovered debris and cuttings material)

Cumulative effects are considered in a broader context, to be potential effects of E&P activities which act additively or in combination with those of other human activities (past, present and future), notably:

- fishing
- shipping, including crude oil transport
- military activities, including exercises (principally in relation to noise)

Synergistic effects – synergy occurs where the joint effect of two or more processes is greater than the sum of individual effects – in this context, synergistic effects may result from physiological interactions (for example, through inhibition of immune response systems) or through the interaction of different physiological and ecological processes (for example through a combination of contaminant toxicity and habitat disturbance).

To some extent, all potential sources of effect (i.e. disturbance, emissions and discharges) resulting from oil and gas activity within an area with a long history of exploration activity are cumulative, insofar as they are incremental to previously existing sources (although the net trend of overall source level may be a reduction, due to improved environmental management and/or declining production levels).

Therefore, effects are considered secondary, incremental, cumulative or synergistic only if:

- the physical or contamination "footprint" of a predicted project overlaps with that of adjacent activities; or
- the effects of multiple sources clearly act on a single receptor or resource (for example a fish stock or seabird population); or
- if transient effects are produced sequentially.

Although the sequential effect concept is considered by the SEA mainly in the context of acoustic or other physical disturbance, the term sequential effect has been developed primarily in the context of sequential visual impact (e.g. for onshore windfarms, from the point of view of a moving observer: SNH 2005).

The SEA Directive (Annex II) also requires, as a criteria for determining the likely significance of effects, consideration of environmental problems relevant to the plan or programme. On the assumption that environmental "problems" are a result of some anthropogenic effect, the potential interactions between potential activities following a 24th Round and recognised environmental problems in the SEA 6 area are considered in this section of the SEA document.

Those potentially significant effects considered to be cumulative are assessed below.

Underwater noise

Consideration of propagation ranges for noise resulting from seismic surveys in the SEA 6 area suggests that consecutive surveys have the potential to produce sequential acoustic disturbance over large parts of the St. Georges Channel and Irish Sea. However, the extent of this is dependent on exploration activity level, operational and timing factors and is impossible to predict. Simultaneous seismic surveys cause acoustic interference and are therefore managed on a cooperative basis ("timeshared"). This has the effect of substantially mitigating the probability of a single receptor receiving disturbance from two or more sources concurrently, but can increase the duration of continuous or sequential disturbance.

In principle, the multiple sources for example two seismic surveys or a seismic survey and another source of noise (e.g. shipping). Although there is no direct evidence for "multiple source confusion" in marine mammals, this represents a possible mechanism for synergistic effect which should be considered further. Possible synergistic effects between seismic survey and military sonars should also be considered further.

In deep water SEA areas, offshore marine mammals distribution has been considered not to be generally confined to localised areas and therefore it is unlikely that individuals in these areas would be exposed to sound levels sufficient to cause significant biological effects for the full duration of a survey. However, in the SEA 6 area the bottlenose dolphin population has a relatively defined distribution; Risso's dolphin and grey seal distributions are also associated with particular areas. Existing regulatory controls over seismic surveys are applied to one survey at a time and there is no clear regulatory mechanism for consideration of cumulative effect. In view of the predicted (relatively low) level of activity in scenario areas 1 and 2, consideration should be given to a precautionary limit on the frequency of seismic survey consented within these areas. No marine mammal species are known to follow regular, tightly defined migration pathways in the SEA 6 area, which could be "blocked" by cumulative seismic disturbance.

The potential for secondary effects of noise disturbance, such as indirect effects on marine mammal predation, are largely unknown although to date, there is no evidence for significant impacts. There is also potential ambiguity on the harm/benefit of behavioural disturbance of marine mammal populations (for example, outside the SEA 6 area, seals are widely perceived to have significant impact on coastal and estuarine salmonid populations, although dietary evidence does not support this conclusion).

Overall, the likelihood of cumulative noise effects from seismic surveys will depend on the timing and location of seismic, but is considered to be low in view of the low predicted activity levels in the SEA 6 area following a 24^{th} Round. Most of the SEA 6 area (scenario areas 3-7) have low marine mammal sensitivities. There is no evidence that substantial E&P activity to date in the North Sea has resulted in direct mortality or acute trauma to marine mammals.

Incremental Simultaneous and sequential surveys in SEA 6 and previously licensed areas.

Cumulative Seismic survey noise and broadband impulse noise, for example military sonars, and continuous mobile sources e.g. shipping

Synergistic Possible multiple source acoustic disturbance

Secondary None known

Physical damage to features and biotopes

Potential sources of physical disturbance to the seabed, and damage to biotopes, were identified as anchoring of semi-submersible rigs, placement of jack-up rigs, wellhead placement and recovery, production platform jacket installation and piling, subsea template and manifold installation and piling, pipeline, flowline and umbilical installation and trenching and decommissioning of infrastructure. Of these, pipelay accounts for greatest spatial extent. Given the forecast scale of exploration and production for the SEA 6 area, it is likely that there would be considerable spatial separation between disturbance "footprints" and a low probability of incremental overlap of affected areas. Recovery of affected seabed through sediment mobility, and faunal recovery and re-colonisation, is expected to be rapid where the source of effects is transient (e.g. anchoring), less than five years. Incremental effects are therefore not considered significant.

Effects of seabed disturbance resulting from SEA 6 activities will be cumulative to those of other activities, notably demersal fishing, aggregate extraction and other offshore construction (e.g. renewable energy developments). The contribution of all other sources of disturbance are minor in comparison to the direct physical effects of fishing, and it can be argued that the positive effect of fisheries exclusion offsets any negative effects of exploration and production. On balance, however, the spatial extents of both positive and negative effects are probably negligible for most seabed habitats.

Existing control and mitigation measures are provided through the *Offshore Petroleum Production and Pipe-lines (Assessment of Environmental Effects) Regulations, 1999* or (in the vicinity of an SAC) from *The Offshore Petroleum Activities (Conservation of Habitats) Regulations, 2001*. The required consenting procedure for specific projects ensures that biotopes of particular conservation or ecological value are identified and afforded appropriate protection.

Incremental Physical footprint incremental to existing oil and gas activity – minor increment

Cumulative Cumulative effects dominated by trawling. In these areas the disturbance effect of oil and gas development is likely to be offset by fishing exclusion.

Synergistic None known

Secondary None known

Physical presence

The physical presence of offshore infrastructure (with associated 500m radius safety exclusion zones) required for exploration and production in shallow waters can have significant direct effects on other users of the affected areas (notably the fishing industry). The predicted incremental effect of exploration and development in the SEA 6 area amounts to 5-10 temporary exclusion zones (not all would be concurrent and spread over a 4 to 5 year period) and up to 3 longer term exclusion zones, a minor increment to the existing area covered by exclusion zones in the SEA 6 area. Visual intrusion of nearshore activities has also been considered by SEA 6, together with physical disturbance of coastal waterbirds by vessel movements and overflights.

Incremental Small increment to existing exclusion zones and obstructions, visual intrusion and disturbance

Cumulative Exclusion and snagging risks are cumulative to those resulting from natural obstructions, shipwrecks and other debris. Extent of cumulative effect associated with 23rd Round is negligible.

Synergistic None known

Secondary None known

Marine discharges

Total produced water discharge from UKCS oil production was 257 million tonnes in 2004, with an average oil in water content of 21.1mg/kg (DTI website). In comparison with this, the potential discharge from new developments following a 24th Round will be negligible since it is expected that the bulk of produced water will be reinjected rather than discharged. Through OSPAR, the UK is committed to a 15% reduction in total discharged volume of oil in produced water by 2006 and there is a presumption against discharge from new developments.

Environmental effects of produced water discharges are limited primarily by dispersion, to below No Observed Effect Concentrations (NOECs). Synergistic interactions are possible between individual components, particularly PAHs, specific process chemicals (especially those which are surface-active, including demulsifiers), and other organic components. However, given the anticipation that the bulk of produced water from SEA 6 area field developments will be reinjected rather than discharged, and that such discharges as are made will be treated to required quality standards, the scope for incremental, cumulative or synergistic effects is remote.

Previous discharges of WBM cuttings in the SEA 6 area have been shown to disperse rapidly and to have minimal ecological effects. Dispersion of further discharges of mud and cuttings could lead to localised accumulation in areas where reduced current allows the particles to settle on the seabed. However, in view of the scale of the area, the water depths and currents, and plans to reinject drill cuttings from a major field development in the area, this is considered unlikely to be detectable and to have negligible incremental or cumulative ecological effect.

Incremental Produced water – incremental contribution of produced water is dependent on the extent of reinjection from existing and SEA 6 developments but noting the presumption against new produced water discharges, the scale of discharge and effects will be negligible. WBM drilling discharges generally disperse widely and significant accumulations do not occur. It is therefore possible that discharge footprints will overlap, although the ecological effects will be undetectable. Potential "sinks" may occur in areas of sediment accumulation although this is considered unlikely to be detectable.

Cumulative Principal cumulative sources of major contaminants, including hydrocarbons and metals, are shipping (including wrecks) and atmospheric inputs. Cumulative sources of particulate contaminants include aeolian dust and sediment disturbance from trawling, although these are negligible in the context of natural suspended particulate loads.

Synergistic Synergistic effects of chemical contaminants in produced water and drilling discharges are conceivable, although substantive data is almost entirely lacking and it is considered unlikely that significant synergistic effects would result from chemicals used in exploration and production operations.

Secondary None known

Atmospheric emissions

Atmospheric emissions from offshore oil and gas exploration and production activities may contribute to reduction of local air quality. Greenhouse and acid gas emissions effectively contribute to a mixed regional or global "pool" and can therefore be considered cumulative.

The implications of the ultimate use of oil and gas production from UKCS for greenhouse gas emissions and on UK commitments under the Kyoto Protocol, were not considered here since these are subjects for different high level policies, fora and initiatives including UK energy policy, security of supply considerations, emissions trading etc.

Flaring from existing UKCS facilities has been substantially reduced relative to past levels, largely through continuing development of export infrastructure and markets, together with gas cycling and reinjection technologies. In addition, offshore oil industry emissions are subject to an Emissions Trading Scheme. New developments will generally flare in substantial quantities only for emergency pressure relief, with "zero routine flaring" now considered a realistic design target for new developments. Other than start-up flaring, subsea tie-back developments will generally have little effect on host installation flaring.

Incremental Incremental emissions resulting from internal combustion for power generation by installations, terminals, vessels and aircraft, flaring for pressure relief and gas disposal, and fugitive emissions during tanker loading.

Cumulative Greenhouse and acid gas emissions effectively contribute to a mixed regional or global "pool" and are therefore considered to be cumulative. On a global scale, cumulative contributions of emissions resulting from SEA 6 activities and developments will be negligible in comparison to the influence of onshore sources.

Synergistic None known

Wastes to land

In view of the relatively small number of wells predicted following a 24th Round in the SEA 6 area, and recent establishment of a licensing mechanism to allow interfield cuttings reinjection, it is considered unlikely that major incremental or cumulative landfill requirement will result from a 24th Round.

Incremental Incremental return of general oilfield wastes insignificant; incremental return of drilling wastes also unlikely to represent a significant contribution to onshore waste disposal requirements.

Cumulative Not quantified

Synergistic None known

Secondary None known

Accidental events

Although the consequences of a major oil spill in the area could be severe, in both ecological and economic terms, the incremental risk associated with the predicted level of activity in SEA 6 is moderate or low. In a study of accidental oil spills and maritime casualties carried out on behalf of the MCA to inform the placement of emergency towing vessels, Safetec (2000) ranked pollution risk[1] in the Irish Sea and Welsh coastline between very low and moderate, with the exception of the Mersey and Milford Haven approaches. High or very high risk rankings were widely distributed through the North Channel, west coast of the Hebrides, Orkney and Shetland, through the Pentland Firth, east coasts of Scotland and

[1] The risk assessment methodology considered frequency, but not sensitivity or consequence

England, Dover Straits and through the English Channel. In relative terms, SEA 6 related activity would not have a significant influence on this assessment and the cumulative risk in the SEA 6 area is therefore low.

Regulatory mechanisms already in place require Operators to develop effective oil spill mitigation measures, covering organisational aspects and the provision of physical and human resources which will minimise incremental risks. Times to beach, under worst case trajectory modelling conditions, are very short. Effective contingency planning and local resources are therefore necessary to allow the deployment of response measures where appropriate.

In terms of cumulative risk, there is little doubt that due to scale and consequence, the major risk of significant oil spills is associated with tanker transport of crude oil and refined products. While some control and response measures have been implemented, for example following the Donaldson inquiry into the *Braer* incident, the residual risk remains relatively high (in comparison to other oil spill sources including E&P).

Other cumulative sources of anthropogenic hydrocarbon input to the SEA 6 area include rivers and land run-off, coastal sewage discharges, dredge spoil, operational shipping discharges and atmospheric deposition. Although cumulative hydrocarbon inputs are often summed for comparative purposes, it is important to note that the environmental effects and fate of individual oil types and sources may be very different. Simple comparison of cumulative inputs may therefore be misleading in terms of effects assessment. In size and frequency terms the majority of oil spills most likely to result from E&P operations will make an insignificant contribution to overall regional inputs.

As context, it may be noted that overall, although the acute effects of oil spills can be severe at a local scale, the cumulative effects of around a century of oil spills from shipping – and thirty years of oil and gas development – do not appear to have resulted in wide-scale or chronic ecological effects. It is therefore concluded that the limited incremental effects of SEA 6 related activity, assuming that effective risk management practices continue to be implemented, will be minimal.

Incremental Hydrocarbons from oil spills will be incremental to (minor) offshore exploration and operational discharges; however, it is considered very unlikely that oil spill footprints will overlap given the predicted spill frequency associated with SEA 6 activities.

Cumulative There are a range of cumulative sources of hydrocarbons to the SEA 6 area. Depending on magnitude, accidental spills represent a minor to major contribution to overall regional inputs of oil.

Synergistic None known

9.13 Transboundary effects

It is a requirement for Strategic Environmental Assessment that transboundary effects are identified, under *European SEA Directive (2001/41/EC)* and the *Espoo Convention*; and this requirement also applies to project environmental assessments conducted under the *Offshore Petroleum Production and Pipe-lines (Assessment of Environmental Effects) Regulations 1999*.

Consideration of transboundary effects is intended to promote adequate consideration of, and consultation between the relevant governments, on transboundary effects where a plan or programme in one state may have significant effects on the environment of another.

The Convention on Environmental Impact Assessment in a Transboundary Context (the *Espoo Convention)* was signed in 1991. This applies to various major activities with the potential to cause transboundary effects and includes offshore hydrocarbon production and large diameter oil & gas pipelines. Projects need to be screened for the potential transboundary effects and an Environmental Impact Assessment and international consultation conducted by government if necessary.

Offshore activities have the potential for transboundary effects, both because of location adjacent to international boundaries and due to the unbounded nature of the marine and atmospheric environment. The SEA 6 area is contiguous with waters under the jurisdiction of Ireland and with the territorial seas of the Isle of Man (Crown Dependency), although prevailing wind and residual water circulation will predominantly result in the transport of atmospheric emissions, marine discharges and spills towards the west coast of Britain. However, SEA 6 activities may occur adjacent to the median line and sources of potentially significant environmental effects, with the additional potential for transboundary effects, therefore include:

- Underwater noise
- Marine discharges
- Atmospheric emissions
- Accidental events – oil spills

All of the above aspects may be able to be detected physically or chemically in adjacent state territories. The scale and consequences of environmental effects from activities resulting from the proposed 24th Round licensing will be less than those in UK waters and are unlikely to be significant.

9.14 Environmental problems

A number of specific environmental problems have been identified by the SEA 6 process, and relevant initiatives such as the Irish Sea Pilot, the Marine Nature Conservation Review the UK Biodiversity Action Plan, fishery management initiatives, UK Sustainable Development Strategy, and international commitments (e.g. under the Kyoto Protocol)

Specific environmental problems, and potential interactions with significant effects of proposed SEA 6 activities, are summarised below. Many of these are noted in the preceding sections, and discussion is not duplicated.

Contamination – broadscale accumulation in sediments and organisms of persistent contaminants, including radionuclides, PAHs and PCBs, is a problem which has been identified and evaluated through initiatives such as OSPAR and the NMMP monitoring programme. Although historic oil & gas activity may have contributed to this problem in mature areas of the North Sea, current regulations will effectively control any future discharges associated with a 24th Round. In the Irish Sea, concentrations of most contaminants have declined significantly in recent years as a result of regulatory controls and changes in industrial mix. Accidental oil spills may contribute to the accumulation of persistent hydrocarbon residues in depositional areas, although the incremental risk associated with potential SEA 6 activities is low.

Fishing sustainability – the sustainability of fishing activities, in terms of direct pressure on stocks, by-catch and habitat disturbance is one of the most significant issues in current marine environmental management (e.g. PMSU 2004). The net effect of proposed oil & gas activities will be neutral or have minor benefit (in terms of protected exclusion areas).

Seabed disturbance – of the human activities which result in physical disturbance of the seabed, demersal trawling is the most significant and oil & gas related effects are relatively minor (see above).

Resource depletion – depletion of natural resources (such as fossil fuels) and long-term sustainability of an industrialised global economy is a widespread concern. Although national energy policy is outside the scope of this SEA, it may be noted that the hydrocarbon reserves associated with SEA 6 are a negligible fraction of the global total (although potentially significant at local and national scales).

Climate change – anthropogenic climate change – and more recently, reduction in ocean pH associated with carbon dioxide emissions – are of global concern. As discussed in section 9.8, the contribution of SEA 6 associated activities is negligible (and may be beneficial in comparison with other fossil fuel sources).

Air quality - Local air quality problems primarily from road transport and industrial emissions occur in urban areas in coasts adjacent to SEA 6 area. Odour complaints have resulted in the past from gas being released from an offshore production installation in Liverpool Bay, although controls are now in place.

Ambient noise – ambient noise is increasingly recognised as a significant problem in both coastal and oceanic environments. Acoustic disturbance, principally associated with seismic survey, is identified by this SEA as a significant issue and mitigation measures and recommendations for addressing data gaps are made.

Spatial congestion – in contrast to most other SEA areas, spatial congestion of parts of the SEA 6 coastal environment is a recognised concern, with options for management currently being addressed through the Defra spatial planning pilot study in Liverpool Bay.

Habitat degradation – concerns over general habitat degradation (including maintenance of biodiversity, and spatial aspects associated with habitat fragmentation) are being addressed at a European level (Habitats & Species Directive, Water Framework Directive) and national level (UK Biodiversity Action Plan, programmes undertaken by country agencies). The implications of these initiatives have been considered throughout the SEA 6 process.

Tranquility/industrialisation – the aesthetic and recreational value of coastlines and coastal waters are fundamental to the economic prosperity of the SEA 6 area (through their importance to tourism) – but increasingly also as an important aspect of "environmental justice" in its widest sense (in a similar way to the positive health and quality of life benefits identified for green space: see e.g. Lucas *et al*. 2004). "Industrialisation" of the offshore and coastal environment, through oil & gas and renewable energy developments, is therefore regarded as a problem by some. However, a negligible contribution to this issue is predicted based on the anticipated scale and nature of SEA 6 activities and developments.

It should be noted that contributions of the proposed activities to environmental problems may be balanced by corresponding socio-economic benefits, in particular, security of energy supply, government and other revenues, employment (level, quality and security) and skills retention (see Mackay 2005b).

9.15 Monitoring

The SEA Directive includes a requirement for monitoring, although the scope of the monitoring is not defined. The types of relevant monitoring already undertaken or proposed for this SEA fall into four types:

- Activity monitoring
- Emissions monitoring
- Effects monitoring
- SEA objectives monitoring

Each of these is summarised below.

Activity monitoring

The scale of oil and gas exploration and production activities resulting from the implementation of the DTI's draft plan to hold a 24th round of offshore licensing will be monitored by the DTI using existing mechanisms to keep track of operator delivery of commitments made at the time of licence application. The SEA has used activity scenarios in the assessment of effects. Actual activity levels over time are compared with the predicted levels, in order to monitor a key basis for the SEA conclusions.

Emissions monitoring

As required by the various environmental permits and other environmental legislative requirements (see Section 3), operators must monitor and report the quantities of solid, liquid and atmospheric emissions, discharges and wastes via the Environmental Emissions Monitoring Scheme and all oil or chemical spills via PON 1. As well as monitoring compliance with individual permit conditions the data provides a benchmark which allows performance trends to be monitored over time, and projected increases from a new DTI draft plan to be placed in context. The DTI's Offshore Environmental Inspectorate is responsible for ensuring that operators comply with environmental legislative requirements and all offshore installations are inspected.

Effects monitoring

There has been extensive monitoring of the effects of offshore oil and gas activities dating back to 1975 in the UK, and a variety of reviews of findings have been undertaken. There is also a large body of monitoring work from other North Sea states and internationally. Studies include operational effects monitoring at a field or regional scales, themed research projects and academic studies. Such monitoring studies continue conducted by individual operators, or under the auspices of the DTI/UKOOA Monitoring Committee, FRS and CEFAS, and the National Marine Monitoring Programme. This existing monitoring activity is reviewed as part of the DTI SEA process and if necessary proposals for further studies would be developed and discussed with the SEA Steering Group.

SEA objectives monitoring

In a consideration of SEA objectives the following factors are pertinent. All receptors in the marine environment are affected to a greater or lesser extent by a range of natural and anthropogenic factors which result in environmental changes at different timescales. Existing environmental damage or unsustainability of certain activities have resulted in a range of mitigative actions being taken over recent years. Finally, there is already oil and gas activity in the areas covered by the DTI's draft plan, generally at declining levels from those in the past but in some instances with legacy contamination and ecological effects at the seabed from discharges no longer permitted. The subject of SEA objectives and indicators was discussed at the Assessment Workshop (see Appendix 3) and the overarching objective for the DTI SEA (see Section 2.2) was agreed.

Subsidiary objectives for the SEA which can be monitored as unambiguous metrics of SEA performance are difficult to identify but based on Assessment Workshop input the following are proposed:

SEA topic	SEA Objective	Proposed SEA Indicators
SEA process	Representative activity scenarios	Accuracy of predicted versus actual activity levels
	Implementation of SEA recommendations	Progress in implementation of SEA recommendations
Biodiversity & geodiversity	Favourable conservation status at designated or relevant sites	No damage by oil and gas activities to features of interest in designated or relevant sites
Population & human heath	Avoidance of bioaccumulation of hazardous materials	Reduction in use of chemical with substitution labels - tracked with EEMS data
Water & soil	Maintenance of environmental quality in the area	Continued attainment of environmental quality objectives in areas of oil and gas activities
Air	No degradation of regional air quality from oil and gas activities	Oil and gas operations compliance with IPPC permit conditions
Climate factors	Beneficial use of hydrocarbons	Volume of gas flared
Cultural heritage & landscapes	Promote awareness and identification of archaeological resources in the area	Adoption of JNAPC and other best practice guidelines in Environmental Statements for oil and gas activities
	Minimisation of adverse impact on marine and terrestrial landscapes	Adoption of DTI and other best practice guidelines in Environmental Statements for oil and gas activities
Other	Contribution to the scientific information base	Proportion of SEA generated data made freely available
	Improved understanding of underwater noise characteristics of exploration and production activities	Number of data reports generated