9. NATIONALLY-IMPORTANT MARINE BIODIVERSITY AREAS

226. Within the draft framework for marine nature conservation, the identification of nationally-important areas is seen less as a separate level of the framework than as an important mechanism for delivering conservation of those marine landscapes, habitats and species which have the most overall value for nature conservation and which are also susceptible to harm from human activities.

227. However, conceptually, the issue of important areas merits attention in its own right. The value of identifying areas of particular importance for biodiversity is based on the principle that these areas make such an essential contribution to meeting the objective of maintaining the range and scale of biodiversity present in the country, that, unless they are enabled to maintain this contribution in perpetuity, this objective will not be met.

228. Furthermore, current thinking on the role of important areas within an overall nature conservation strategy is that these areas should be seen not (or not only) in isolation as individual areas but also as components of an ecologically-coherent network of areas. Individual areas within this network should have the capability of supporting one another ecologically, and also of supporting, and being supported by, the areas of sea and seabed adjacent to them.

229. One of the tasks identified by the Review of Marine Nature Conservation was to develop a clear rationale and justification for a series of nationally-important areas for biodiversity in the marine environment, and a suite of agreed criteria for selecting them. As part of this work, JNCC was requested to develop draft criteria. Drawing extensively upon existing and current work in other fora, notably the selection guidelines for Sites of Special Scientific Interest, the EC Habitats and Birds Directives, IUCN and OSPAR, a criteria paper (Connor *et al.*, 2002) was prepared which provided a suite of draft criteria. The paper was endorsed by the Review of Marine Nature Conservation Working Group for the purpose of trialling on the Irish Sea as part of the Pilot.

230. From the foregoing, the Pilot identified the following main tasks:

i. to formulate a clear rationale and justification for the selection of a network of nationally-important areas, applicable at the Regional Sea scale;

ii. to test out the draft criteria for the selection of nationally-important areas on the Irish Sea;

iii. to investigate, as necessary, the use of additional methodologies to create a network of nationally-important areas to support the practical conservation of marine landscapes, habitats and species.

The concept of networks of nationally-important areas

231. Marine species are a combination of highly mobile pelagic species (pelagic invertebrates, fish, seabirds, sea mammals, etc) characteristically capable of moving sometimes hundreds of kilometres in a year, either under their own power or as a consequence of currents or wind, and also of seabed species which normally have a mobile larval/immature phase. The relative mobility of this larval/immature phase is dependent on species and circumstances (currents, etc), but such species often have the ability to travel several tens of kilometres before they metamorphose and settle on the seabed. Since, the biological component of seabed habitats is comprised of seabed species, seabed communities have the same mobility capability, though the ability of habitats to develop fully in new areas depends on the suitability of substrate, depth, temperature, etc, and the relative mobility of the constituent species.

232. Because of this mobility, marine species and communities occurring in one sea area have the potential to move to, or colonise, adjacent, and sometimes quite distant, areas of sea. A network

of mutually-supporting areas, or areas capable of supporting the biodiversity of a neighbouring sea or seabed area, is, therefore, a practical ecological proposition.

233. As part of its work, the Pilot commissioned a review of current information and thinking on ecologically-coherent networks of important areas from the Environment Department of the University of York. The report of this work is available (Roberts *et al*., 2003).

234. The main principles in the development of important area networks, as set out in the contract report, can be summarised as follows:

i. networks should be designed to ensure that areas are mutually supporting (i.e. populations of animals and plants in one area should be capable of supporting, and be supported by, populations in other areas);

ii. networks should seek to incorporate the full spectrum of biological diversity (not just that subset which relates *inter alia* to rarity, endangerment, or other pre-selected importance values);

iii. examples of habitats (or concentrations of species) should be replicated in separate areas;

iv. the total area of the network, and its distribution in terms of individual component areas, should be capable of meeting the objective of sustaining species and their habitats in perpetuity;

v. the best available information should be used in site selection, but the development of the network should not be delayed pending action to collect further information.

These principles have largely been adapted from those proposed by Ballantine (1999).

235. Paragraphs 236-242 below elaborate these principles somewhat, on the basis of current thinking.

The principle that sites within a network should be mutually supporting

236. Because of the inherent mobility of marine species and communities, genetic exchange between sites can take place, and a species lost from a given site may be replaced by colonists from another. This potential for mutual support needs to be considered at the time of area selection, although, because water movements are so extensive and variable, detailed knowledge of dispersal patterns along them is not essential. Consideration of biogeography, and of the general layout of water masses, would generally be sufficient. Furthermore, highly mobile or migratory species may be able to utilise a range of areas for feeding or breeding at different times. Because of this mobility, a network of sites can be capable of accommodating and adjusting to dynamic and other environmental changes, such as climate change.

Network design should incorporate the full spectrum of biological diversity

237. The purpose of this principle is to ensure that the areas selected reflect the full range of marine biodiversity present in the country, not just those elements identified through the application of pre-determined values such as rarity (though not excluding these). This is a strategic approach to maintaining the full range of national and regional biodiversity over time as opposed to taking action only when a habitat or species has become threatened, an approach which will almost certainly result in progressively smaller species populations and areas of habitat. Levels of protection afforded to the areas selected need to be capable of sustaining the range of biodiversity naturally characteristic of the area, and not confined to pre-selected elements. This is to avoid human activity suppressing or eliminating some elements of biodiversity, with the result that the area does not reach its full potential.

Area replication

238. The purpose of area replication is to insure against the risk of individual areas being damaged, and their biological components being reduced or lost, as a result of a damaging natural occurrence or human activity. Several examples of the same area type are, therefore, selected in an effort to avoid this. Replicate areas should, ideally, be separated from each other sufficiently to ensure that an impact which damages one area does not also damage the others. However, the replicate areas should not be located so far apart that organisms from an undamaged area cannot re-colonise and restore a damaged one.

Extent of area

239. As on land, the general principle that large areas are preferable to small ones applies to the marine environment, but, also as on land, examples of some types of habitat (e.g. some reef systems or gas seep structures) may be sufficiently protected at fairly modest scales (e.g. 5km^2), having due regard also to the practicalities of regulating potential adverse human impacts. Clearly, if the occurrence of a particular habitat-type is itself limited, this will constrain the size of the area selected. For habitat types which depend for their structure and function on processes potentially operating over extensive areas (e.g. shallow subtidal sandbanks), significantly more extensive areas (e.g. 1,000-5,000km^2) may be needed.

240. As regards the total extent of a network, this will depend on a) the degree of variability of the habitat (i.e. a high level of variability is likely to lead to a requirement for a larger number of areas), and b) the degree to which the sea or seabed outside the network is likely to be adversely affected by human activities (i.e. the greater the level of impact outside the network, the greater the proportion included within the network needs to be). As a guide, a body of experience appears to be emerging which suggests that 10-15% of the marine area should be included within important area networks. Where a habitat type is limited in extent, the proportion should be higher (perhaps 30-40% and, in cases of habitat rarity, in excess of this). Conversely, if the habitat is widespread and relatively uniform, the proportion could be lower (perhaps 7-10%). These figures do not incorporate consideration of the area required to support mobile, commercially-exploited fish species.

Use of most appropriate information

241. Where detailed biological information exists, it should be utilised in area selection. Indeed, as regards identifying concentrations and aggregations of mobile species such as seabirds and sea mammals, the availability of adequate biological data is essential. However, for the purposes of identifying a representative series of habitat types within a network, techniques have been developed which do not require such detailed biological information. For these, a lesser level of information could be acceptable, for instance the level of information used to define and validate marine landscapes.

242. The density of selected areas for benthic or demersal features as part of a network, and thus the distance between them, will be dependent on the state of the seabed in between. Characteristically, although some seabed species are capable of being transported up to some tens of kilometres (or further, exceptionally) in their larval phase, much settlement actually occurs quite close to the site where the parents occur. This allows 'seeding' into the adjacent localities, and potentially enables these localities and the areas within the network to provide mutual support. The less intensively the adjacent sea is impacted by human activities, therefore, the lower the density of areas within the network needs to be and probably also the smaller the overall extent of the network.

Discussion

243. An ecologically-coherent network is likely to contain the following elements:

i. representative examples of all the broad marine habitat types;

ii. areas of exceptional habitat or species biodiversity;

iii. important areas for aggregations of mobile species, (e.g. important spawning, nursery, calving, feeding or resting areas, and migration bottlenecks).

244. Separate networks should be developed for each of the main biogeographical regions. For example a network including all the elements described in paragraph 243 above should be selected for each 'Regional Sea'. This is because the biological characteristics of each of these Regional Seas will be significantly different from the others.

245. In the creation of a network, it is often possible to consider a number of potential areas before selecting a representative example of a habitat. Where this is the case, other considerations (e.g. low threat likelihood, contribution to sustainable fisheries, recreational and research potential) can all be considered in area selection. Sites which have already been selected for protection (e.g. under the EC Birds and Habitats Directives) could be expected to be selected for inclusion within the network in preference to other, similar, areas. Sustainable development necessitates involving sectoral interests and local communities in area selection. For example, fishing interests may be able to identify areas where the provision of additional protection would support their interests.

Testing the Draft Criteria

246. The draft criteria for the identification of nationally-important marine areas were given in Connor *et al.* (2002) as:

1. Typicalness: the area contains examples of marine landscapes, habitats and ecological processes or other natural characteristics that are typical of their type in their natural state.

2. Naturalness: the area has a high degree of naturalness, resulting from the lack of human-induced disturbance or degradation; marine landscapes, habitats and populations of species are in a near-natural state. This is reflected in the structure and function of the features being in a near-natural state to help maintain full ecosystem functioning.

3. Size: the area holds large examples of particular marine landscapes and habitats or extensive populations of highly mobile species. The greater the extent the more the integrity of the feature can be maintained and the higher the biodiversity it is likely to support.

4. Biological diversity: the area has a naturally high variety of habitats or species (compared to other similar areas).

5. Critical area: the area is critical for part of the life cycle (such as breeding, nursery grounds/ area for juveniles, feeding, migration, resting) of a mobile species.

6. Area important for a nationally-important marine feature: Features that qualify as special features or which are declined or threatened should contribute to the identification of these areas. The assessment should consider whether such features are present in sufficient numbers (species), extent (habitat) or quality (habitats, marine landscapes) to contribute to the conservation of the feature.

The purpose of trialling the draft criteria was to determine whether they were fully satisfactory, and to develop methodologies for applying them in practice.

Methods

247. The initial approach adopted in applying the criteria was to apply them to areas within individual marine landscape types in turn. If the criteria proved effective this should result in the identification of areas containing 'best examples' for each marine landscape type. The overall series of areas identified would encompass the full range of marine landscapes, and, assuming that marine landscapes may be used as a surrogate unit for other components of the marine ecosystem (e.g. species, habitats), it would ensure a full representation of marine biodiversity. In order to test the effectiveness of the draft criteria, two marine landscape types were selected for trialling this approach, namely 'Estuaries' and 'Coarse Sediment Plains'. The Estuaries marine landscape type was selected as an example of the 'coastal' group of marine landscapes. In this group the boundaries of sites within this landscape type are clearly defined, and, being coastal in nature, biological data are relatively plentiful. The Coarse Sediment Plains[1] marine landscape type was selected as an example of the 'seabed' group of marine landscapes; boundaries of these landscape types are often broadly-defined, and being largely offshore in occurrence, biological data relating to them are often sparse.

248. With reference to the individual draft criteria, 'typicalness' was assessed by a range of methods including identifying the characterising biotope complexes for the marine landscape and selecting specific examples of the marine landscape to encompass the range of biological character. Examples of marine landscapes were rated for 'naturalness' by ranking them in relation to the relative absence of human-induced disturbance or degradation. 'Size' was calculated from the GIS layer containing the marine landscape polygons. Biological diversity was determined using the Banded Ranked Relative Richness method described in Connor & Hill (1998), which ranks the areas according to the number of species (or biotopes, or biotope complexes) recorded in each, and then splits the ranks into 5 bands of equal width. The highest ranking areas receive a BRRR score of 5, the lowest ones a score of 1. Information used for the assessment came from a variety of sources; the benthic data were from the JNCC marine habitats database and from the Irish Sea Seabed Image Archive (ISSIA) (Allen & Rees, 1999).

249. For 'Critical area', a determination was made as to whether the site overlapped with a Special Protection Area designated for its seabird or intertidal waterbird populations (the same approach could be used in relation to 'marine species' Special Areas of Conservation and to important fish sites, but this was not done as part of the test). Finally, the 'Area important for nationally-important marine feature' criterion was applied to the extent of identifying the numbers of habitats and species recorded for each Estuary which were on the Irish Sea provisional list; however, this criterion was also considered separately for the Irish Sea as a whole.

250. Because their boundaries were defined, it was easy to identify a range of estuaries against which to test the criteria. A set of 28 estuaries, all in the UK, were included in the test. An attempt was made to carry out a similar test for the Coarse Sediment Plains, which occur as large continuous areas of seabed. A 10km by 10km grid was used to produce a series of grid cells that could be compared using the methods outlined above.

Results

251. The results of applying the criteria to 28 Irish Sea estuaries is summarised in Table 7, which provides an overview of the rankings allocated against each of the estuaries for each of the criteria.

[1]Coarse Sediment Plains were subsequently separated into two types in the Marine Landscapes classification, namely Low bed-stress Sediment Plains and High bed-stress Sediment Plains, but in the criteria test these types were combined.

Table 7. Overview of rankings allocated to each estuary for each criterion.

The order of estuaries in this table is not significant, i.e. no overall ranking of estuaries issuggested.

Abbreviations: Typicalness: **C**, **D** and **E** refer to Water Framework Directive types following Rogers *et al*. (2003); **G** to general estuaries marine landscape; ***** refers to additional areas required to represent the range of estuarine complexes fully. For the ranking scores, 5 is the highest score against the relevant criterion in each case. **Y** refers to estuaries which are SPA for seabirds or intertidal waterbirds, **y*** denotes estuaries which only partly overlap with an SPA. The figures shown in the 'Area important etc' column are numbers of habitats and species on the nationally-important provisional list recorded from the estuary.

Estuary	Diversity of biotope complexes	Diversity - biotopes	Diversity - species	Typicalness	Naturalness	Size	Critical area – birds (SPA)	Area important for nationally important habitat or species
Water of Fleet	4	4	4		5	3		4
Afon Teifi	5	5	5	C; G	4	3		3
Malltraeth Sands (Afon Cefni)	3	2	2		5	3		2
Rivers Esk, Mite & Ir	5	5	5	E; G	4.7	2		6
Mochras Lagoon (Artro estuary)	2	2	3		3.7	2		3
River Dee	4	4	4		2	5	y	3
Cree & Bladnoch estuaries	3	3	3		4	5		1
River Lune	3	3	3		3	3	y*	2
Afon Nyfer	4	4	4	C; G		2		0
Duddon Sands	5	5	4		2.7	4	y	3
Solway Firth	5	5	5	*	3.3	5	y	10
Clyde estuary	1	1	3		1.3	4		1
River Leven	3	3	2		3	4	y*	1
Cresswell & Carew Rivers	3	3	5	*		2		4
Afon Mawddach	5	5	5	C; G	4.7	3		4
Afon Dyfi (River Dovey)	4	4	4		4.3	4	y	2
Nefern estuary	1	1	1			1		0
Ffraw estuary	1	1	1			1		0
Traeth Bach (Glaslyn & Dwryryd)	4	4	4		4.3	4		2
Pilanton Burn & Water of Luce	1	1	1		4.3	2	y*	0
W & E Cleddau	2	2	3	*	4.5	3		2
River Ribble	3	3	3	E	2.3	5	y	3
Afon Reidol & Ystwyth	2	2	2		2.7	1		0
River Kent	3	2	2		3	4	y*	1
Afon Dysynni (Broad Water)	2	2	2			2		1
Aeron estuary	1	1	1			1		0
Dwyfor estuary	1	1	1			1		1
River Mersey, inc. Alt	2	2	2	D	2	5	y	2

252. Table 7 provides an overview from which conclusions on those estuaries which would qualify as being nationally-important can be made by applying the following method:

i. include those examples which support the highest biodiversity;

ii. include sufficient examples to represent fully the biotope complexes characteristic of the marine landscape feature;

iii. check examples are acceptably natural and are appropriate in size.

As a result of difficulties encountered trying to apply the 'Critical area', and 'Area important for nationally-important marine feature' criteria to individual marine landscapes, it was concluded that these criteria are assessed better at the Regional Sea scale, as these criteria are, to some extent, independent of the individual marine landscape types.

253. The thresholds for selection remain a matter for discussion and consideration. It should be noted that it may not be simply a matter of selecting the highest scoring estuaries since there may be a need also to include certain lower-scoring estuaries within the network to encompass the full range of ecological variation. Nonetheless, once thresholds for 'national importance' are set, it will be appreciated that they will be able to be used with confidence when the criteria are applied to estuaries independently of the national/regional/local context providing that natural differences resulting from biogeographical variation are also taken into account.

254. For the Coarse Sediment Plains, it was found that most of the 10km x 10km grid cells selected contained few or no data records. Applying the criteria to such a site series could yield no meaningful results and the methodology proved impractical. The inevitable conclusion has to be that, at the moment, the criteria cannot be applied with confidence to the majority of marine landscape types which occur primarily in non-coastal situations using the methods as described for 'Estuaries'.

Discussion

255. The draft criteria could be applied successfully for the identification of nationally-important areas for marine landscape types for which there are sufficient data available. Data coverage is relatively good in coastal areas, both in terms of records on the JNCC marine database and in terms of additional published information and the grey literature. The marine landscape types falling into these areas are principally Estuaries, Rias, Saline Lagoons, Sea Lochs and Sounds. The application of the criteria to these marine landscapes is facilitated by the fact that they have fairly clearly-defined natural boundaries, i.e. they fall into discrete spatial units which can be compared. Examples of some types of the more offshore seabed marine landscapes may also be naturally well defined, for example Gas Structures, Sea Mounds and, potentially, Photic and Aphotic Reefs, and Deep-water Channels. However, the criteria could only be applied successfully to these marine landscape types if sufficient data were available.

256. Sediment-dominated marine landscape types are generally too large or continuous to allow comparison between examples using natural boundaries. If sites are defined by a grid-cell system, however, the size criterion is of limited use, though clustering of high-scoring adjacent grid cells could be taken into account. However, the main problem for these areas is the scarcity of data, which, at the moment, prevents the criteria from being applied effectively to offshore marine landscapes.

257. The approach of applying the criteria to each marine landscape type in turn will, therefore, only go part of the way to identifying a full suite of nationally-important areas within a Regional Sea. Where sufficient information is available, the first four criteria (naturalness, typicalness, biodiversity and size) can be applied to individual marine landscape types in turn. However, applying the last two criteria ('critical area' and 'important areas') as part of the process of identifying representative examples of the main habitat types proved more problematic. It was concluded that:

i. in relation to selecting representative examples of main habitat types, criteria 1-4 of paragraph 246 could be employed in situations where these habitat types occurred as relatively discrete, naturally-defined, areas and potentially for other types using a grid cell system, for which there are sufficient biological data;

ii. criteria 5 and 6 of paragraph 246 are best applied separately at the Regional Sea scale;

iii. alternative methodologies are needed to select representative examples of the main habitat types when biological data are scarce.

258. Additional methodologies to address the needs of points ii. and iii. above were investigated as part of the Pilot and are reported below.

Additional methodologies for creating a network of nationally-important areas

Critical areas in the life cycle of mobile species

259. Work to identify nationally and internationally-important localities for intertidal non-breeding waterfowl populations, and also for seabird breeding colonies, has been ongoing for many years, and guidelines for the selection of these as Sites of Special Scientific Interest in Great Britain, and as Special Protection Areas in the United Kingdom, have been published respectively by the Nature Conservancy Council (1989) and the Joint Nature Conservation Committee (1999). Detailed population figures for all major sites in the United Kingdom, including intertidal areas, are provided annually through the Wetland Bird Survey (Pollitt *et al.*, 2003). A similar scheme (I-WeBS) is operated in the Republic of Ireland. A census of most of the important seabird colonies in Britain and Ireland was undertaken between 1999-2002 and the results will be published during 2004.

260. Work to identify important marine resting and feeding sites for assemblages of seabirds (including seaduck, divers and grebes) as a component of the UK network of Special Protection Areas is currently being undertaken by JNCC and the country nature conservation agencies. Methods are based on the statistical analysis of recorded seabird densities in conjunction with the published SPA selection guidelines (Joint Nature Conservation Committee, 1999). To date, sites have been selected for black scoter at Carmarthen Bay (just outside the Pilot area), and are being considered for black scoter and red-throated diver at Liverpool Bay.

261. Guidelines for the identification of important areas for seals have been published by the Nature Conservancy Council (1989) for Sites of Special Scientific Interest, and by the Joint Nature Conservation Committee (McLeod *et al.*, 2002), for Special Areas of Conservation. Data on the distribution of cetaceans in British and Irish waters has been compiled and the results published (Reid *et al.*, 2003). A statistical approach is being taken to investigate the appropriateness of selecting Special Areas of Conservation for harbour porpoise.

262. Records of basking shark occurrence have been collated and the results are shown in Map 17. The data indicate concentrations of sharks around the southern and western coasts of the Isle of Man, in the Clyde Sea particularly around the coasts of the Isle of Arran, and, locally, off other coasts in the northern part of the Irish Sea area. While this distribution certainly demonstrates the occurrence of basking sharks in these waters, at least in summer, the data are also likely to reflect, to some extent, the relative intensity of recorder effort. From the Solway Shark Watch, basking sharks are also known to use the Solway Firth and waters off the Cumbrian coast and Morecambe Bay, but those data have not been contributed to the Pilot database. At this juncture, it is difficult to conclude whether including areas for this species within an area network would be of material conservation benefit to the species.

263. Areas considered to be important spawning and nursery areas for commercial fish species were combined and are shown in Map 18. However, the relatively widespread nature of areas critical for one or two mobile species raises the potential problem of attaching the 'nationally-important' label to large areas of sea. This could result in protection being extended over large areas but resulting in few conservation benefits. It may be better to use integrated regional sea-scale management approaches to avoid the destruction of large spawning and nursery areas, and to

prevent the decline of mobile species, unless such areas are critical for the survival of a number of mobile species, or host very dense aggregations of a mobile species.

Important areas for nationally-important benthic species and habitats

264. Map 19 shows the number of benthic species which occur in each 5km by 5km grid cell within the Irish Sea. Map 20 uses the same grid cell system to show the number of benthic habitats and species on the provisional list of nationally-important features. The overall pattern of distribution and density between these two maps is similar. Areas where high numbers of nationally-important marine features are recorded could qualify under this criterion. On the basis of available data, those grid cells showing the highest diversity of nationally-important features do represent real biodiversity 'hotspots'. What cannot be asserted, because of the scarcity of data, is that similar 'hotspots' do not also occur offshore. However, a conservation strategy has to have full regard to the data which are available, and Map 20 indicates such hotspots along the coasts of Dyfed, Lleyn Peninsula, Anglesey and the Menai Straits, southern Isle of Man, northern Clyde Sea, Strangford Lough and adjacent coasts of Co. Down, and Co. Waterford.

High diversity marine landscape areas

265. It is apparent from the map of coastal and seabed marine landscapes (Map 12), that areas of the Irish Sea differ in their variety of marine landscapes. Some areas are relatively uniform, with one or two marine landscapes, in others many more types of marine landscape are to be found. The grid cell system was used to compare the relative diversity of marine landscape areas, and the results are shown in Map 21. Areas of high marine landscape diversity can be used to identify probable areas of high biodiversity where biological data are scarce, and this approach could be used to identify probable diversity hotspots in such areas. Map 21 indicates areas of high marine landscape diversity off the coasts of Co. Antrim and Co. Down and eastwards to the Mull of Galloway, off Anglesey, off the coasts of Co. Wexford, Co. Waterford and Dyfed.

The use of the software tool Marxan in identifying a suite of nationally-important areas

266. Applying the first four criteria to data-rich inshore marine landscape types, and identifying areas qualifying under the last two criteria based on best available information, will result in a set of areas identified as nationally-important. However, it will not ensure that the full range of marine biodiversity is represented within those sites - additional areas need to be selected for the data-poor marine landscapes. Furthermore, it will not take into consideration ecological network principles such as those outlined in paragraphs 236-242. Additional areas are needed to develop an ecologically-coherent network, taking into account those areas already identified as nationally-important.

267. The use of the software tool Marxan (Ball & Possingham, 2003) was investigated to address the issue of prioritising areas at the Regional Sea scale. The Marxan process starts by dividing the Regional Sea into small (planning) units. Targets are set for conservation features, and Marxan identifies sets of planning units with which those targets can be met (e.g. it can be instructed to select units sufficient to contain 3 records of each nationally-important benthic species and a specified % of the total area of each marine landscape). Each planning unit has a cost (in the simplest case, a measure of its size), and Marxan finds the cheapest 'networks' of planning units in which the targets are met. The process can be constrained in a number of ways to take a range of factors into consideration, for example:

i. different targets can be set for any number of conservation features, or for any measurable spatial unit, e.g. targets could be set to represent a given percentage of known nursery or feeding grounds of mobile species;

ii. a boundary length modifier can be used to minimise the overall boundary length of the selected 'network' of planning units, in order, for example, to avoid the programme selecting highly scattered sets of planning units;

iii. it is possible to increase the relative costliness of planning units if they are in areas of intense human activity (therefore less natural); to lock areas into the process (e.g. estuaries already identified as nationally-important, existing protected areas (such as those indicated on Map 22), biodiversity hotspots etc), and to lock areas out of the process (e.g. areas known to be unsuitable for the potential location of future marine protected areas due to current or planned human activity).

There is no limit to the number of data layers that can be incorporated into the process: any spatial data in GIS format can be used. A number of scenarios were run for the Irish Sea Pilot, using different combinations of datasets and constraints.

268. Marxan yields two types of maps as a result of running each scenario. The algorithm it uses includes a random element, which means that each time the same scenario is run, the answer will be slightly different. By running the same scenario many times, it is possible to work out the percentage of runs in which each planning unit was picked, resulting in a value of 'irreplaceability' for each planning unit. In addition, the 'best solution' map shows the solution with the lowest total cost. It is important to look at both in conjunction. The 'irreplaceability' map shows the relative importance of areas for meeting the targets, and allows for prioritisation between areas. The 'best solution' map gives a clear indication of the amount of area necessary for meeting the targets. Map 23 and Map 24 show the results of running the scenario where the cost of planning units was scaled according to naturalness, and where high biodiversity areas and existing SPAs and candidate SACs were locked in.

269. Note that the success of the recommended process for the identification of nationally-important marine areas depends on other pieces of work having been completed. Most notably, a map of marine landscapes is needed. Data on human activity have to be collated in GIS format to be able to take naturalness into consideration as a factor. Targets for features such as marine landscapes, species and habitats within the selected areas have to be set bearing in mind the limitations of the data on the distribution and abundance of these features. The outcome of using the Marxan software tool is dependent on the quality of the data that it is provided with - it cannot solve problems relating to data quality, coverage and uneven sample distribution. Expert judgement will always be needed to determine why some areas show up as more important than others, and to some extent this will depend on the available data which were incorporated at the outset. Problems of missing and uneven data will be present whichever way the criteria are applied. However, Marxan has a number of advantages over other approaches:

i. it provides a step in the process of applying the criteria which looks at many factors simultaneously, areas are not identified independently from each other - they are selected to complement each other;

ii. it ensures efficient, full representation of known biodiversity;

iii. it allows the inclusion of areas already identified as nationally-important;

iv. while Marxan cannot apply the criteria directly (it does not measure biodiversity or naturalness), it allows incorporation of the criteria in the area identification process;

v. the software is flexible and can be run on any number of different scenarios, this enables an interactive process of identifying nationally-important areas;

vi. the outcome of Marxan is still open for interpretation - there is no need to let the software 'dictate' the location of nationally-important areas. However, the irreplaceability maps are extremely useful to allow prioritisation between areas.

Discussion

270. It can be concluded that the draft criteria (Connor *et al.*, 2002) are basically sound, with the proviso that the 'critical area' criterion should not result in large areas being identified for the purpose of conserving one or two mobile species unless the area hosts dense aggregations of such species. A variety of methods will need to be employed when applying these criteria, depending on the availability of the data and the mobility of species. A minor modification to one of the criteria is suggested, namely to criterion 5 (critical area for part of the life cycle of a mobile species) where it is recommended that the relative scarcity of such areas is taken into account. The revised guidance is provided at Appendix 5.

271. An ecologically-coherent network of important areas, with attention given to the location of areas within the network to enable them to carry out their mutually-supporting function most effectively, will be a crucial conservation tool and one which is capable of contributing to the economy including through support to tourism and sustainable fisheries.

272. Such an ecologically-coherent network will contain some areas which have been identified so as to support specific aspects of biodiversity, together with areas which have been selected to contribute to the range of biodiversity elements characteristic of a particular sea area. It is fundamental to this concept that areas, once identified, should receive appropriate protection from the effects of human activities. These issues are discussed further in Chapter 12.

273. A necessary development in the use of the Marxan tool is to consider further, and obtain consensus on, the targets selected for the various components of biodiversity contributing to the area network. This is a key issue for further work.

Recommendations

274. The recommended process for identifying nationally-important marine areas at the regional sea scale can be represented as follows:

R19 An ecologically-coherent network of nationally-important areas for the Regional Sea should be identified using the criteria set out in Appendix 5, and the principles set out in this Report. Proportionate and relevant measures should be taken to protect these areas from harm as a result of human activities.

R20 In the selection of nationally-important areas, for those marine landscapes where there are sufficient data available, representativity and biodiversity criteria should be applied and 'best examples' identified. Using best available information, areas qualifying under critical area or nationally-important features criteria should be identified as far as possible.

R21 For data-poor (normally offshore) areas, GIS data should be collated to allow a broadscale scoring of areas against the naturalness and biodiversity criteria. A marine landscape classification is necessary to use as a surrogate for more detailed ecological data. Marxan can then be used to complete the identification of a full set of nationally-important areas within the Regional Sea. This process should take into consideration best available information on naturalness and typicalness, the distribution of records of nationally-important marine features, patterns of biological diversity, and the distribution of marine landscapes.

275. A full report of the work carried out on the nationally-important areas is available in Lieberknecht *et al.* (2004b) and online at **www.jncc.gov.uk/irishseapilot.**