

# 4.1 Marine Environment Research Programme

*"Ireland's environment is a vital natural resource, which we all depend on and consequently must cherish. It has its own intrinsic worth; it is central to a good quality of life; it is vital for the well being of future generations; and it is a key part of what attracts people and investment to Ireland. In short, a high quality environment is essential for economic progress and for sustainable development."<sup>32</sup>*

## 4.1.1 Current Status of the Marine Environment

Ireland is fortunate amongst European countries in having relatively unpolluted marine and coastal waters, though they are not pristine<sup>33</sup>. The environmental quality of Ireland's estuaries, bays and coastal waters remains generally high in a European context, despite substantial population growth and economic development over recent decades.

However, it should be noted that the 2004 State of the Environment Report highlighted the fact that several estuarine areas are seriously affected by direct municipal and, in some instances, industrial discharges, in combination with nutrient loads carried down by rivers. The most significant sources of organic matter and nutrients are agricultural runoff and urban wastewater discharges. A number of major estuaries, predominantly in the east and south of the country, have been classed as eutrophic under assessments carried out by the EPA. As well as impaired water quality, the potential impacts of direct and indirect discharges include loss of amenity value, interference with fisheries and aquaculture, and changes in natural plant and animal communities.

The marine waters around Ireland are considered some of the most productive fishing areas of the northwest European continental shelf. However, exploitation rates in recent years have been very high. Of the 56 commercially targeted marine fish stocks in Irish waters, 25 are overexploited and the status of many others is uncertain. Fishing can also give rise to adverse impacts on non-target species, e.g. damage to deep-sea coral reefs off the west coast.

Contaminant levels in fish and shellfish are low, according to the most recent monitoring surveys, and the overall quality of Irish seafood produce remains high.

In 2004, the number of marine bathing waters that complied with EU Bathing Water Directive standards reached 122. Of these, 97% complied with the minimum mandatory standards and 83.6% complied with

<sup>32</sup> Dept. of Environment and Local Government (2003). Making Ireland's Development Sustainable.

<sup>33</sup> EPA (2004). Ireland's Environment 2004.

the more stringent guideline standards of the Directive. Seventy three beaches and two marinas were awarded Blue Flags in 2005.

Although litter on beaches continues to be a problem, the 2002 plastic bag levy has significantly reduced the use and disposal of plastic bags in recent years.

#### 4.1.2 Key Opportunities and Challenges

##### Implementing Current and New Environmental Legislation

Ireland will take a proactive role in the development of tools and methodologies for the implementation of the Water Framework Directive (2000/61/EC), which requires monitoring and assessment of ecological quality in coastal and transitional waters. Ireland will seek to take a lead role in the evolution of the EU Marine Strategy, which is likely to provide a basis for a Marine Framework Directive and integrated, ecosystem-based management of the EU's marine resources. The implementation of the EU Marine Strategy is likely to strengthen the legislative status of the OSPAR Convention for EU member states. In order to achieve this, Ireland will mobilise marine research capabilities to inform legislative and policy choices.

##### Sustainable (Sectoral) Development

The National Sustainable Development Strategy sets out the need for a well-managed environment that sustains a healthy economy and a good quality of life. This reaffirms the requirement for mutually supportive policies to achieve a balance between society, economy and environment. Within this context, the ecosystems approach has emerged as a fundamental delivery mechanism for achieving sustainable development, based on maintaining fully functioning ecosystems. Progress will require more coherence and better integration of management and regulatory systems across all sectors. Although there are existing measures in place to reduce and control pressures and threats on the marine environment, e.g. relevant EU Directives and OSPAR strategies, they have typically been developed and implemented on a sector-by-sector basis.

Most sectoral policies address diverse uses, pressures, impacts, and major ecosystem components (fish, seabirds, water quality and habitat features) separately. However, there is growing acceptance of the need to consider interactions and cumulative effects arising out of multiple uses of the marine ecosystem and to address these through policy instruments that adopt a more integrated and holistic approach.

Within Europe, the Ecosystems Approach features prominently within the reformed Common Fisheries Policy, OSPAR and the new EU Marine Strategy. Although guidance will be provided through these mechanisms, research will be required at member state level to determine the specific objectives, approaches and indicators.

##### Environmental Understanding

Ireland needs to invest in research to provide an adequate baseline of the characteristics of the marine and coastal environment. This would include a programme of research in physical, chemical and biological properties and processes; a baseline assessment of resources (e.g. seabed resources); and the development of appropriate models. Such data sets and models would provide the scientific input needed for the assessment and governance of the marine sector. They would also allow appropriate environmental indicators to be developed and used in determining trends, e.g. impacts of climate change. **The challenge posed by climate change is dealt with under the Discovery Research Measure (Section 3.5)**

### **Environmental Quality and Protection**

In accordance with international conventions to which Ireland is a party (e.g. OSPAR Convention, 1992), Ireland is expected to carry out regular assessments of the quality of the marine environment including water, sediments and biota. Ireland is also obliged under the Water Framework Directive to achieve good ecological and chemical status in its waters by 2015. The achievement of this objective requires implementation of a national research and monitoring programme for water quality in transitional, coastal and marine waters. A key element in this process is the development of appropriate ecological objectives and targets, supported by indicators. This national monitoring and assessment programme will be carried out co-operatively by several agencies including the EPA, Marine Institute, River Basin Districts, RPII and local authorities.

### **Protecting Marine Biodiversity**

The maintenance of biodiversity in Irish waters demands effective regulation backed by coherent programmes of scientific research. The richness of our marine biodiversity can be measured by the range of habitats, the number of species and their genetic variety. In accordance with the National Biodiversity Action Plan, as well as other UN and EU legislation, Ireland needs to implement a prioritised programme of marine species and habitat mapping and surveying. Based on this programme, Ireland will adopt specific provisions in our spatial planning and resource management for the conservation of marine biodiversity. The maintenance of biodiversity also provides a potential resource for biodiscovery and marine eco-tourism, and conserves Ireland's marine heritage for future generations.

### **Enhanced Monitoring Capability**

Ireland can build on the investment made in marine research infrastructure, e.g. research vessels, laboratories and communications technology, to achieve a more efficient and effective marine monitoring system. Ireland has already built expertise in microelectronics, sensors and data management, which provides further opportunities to develop automated systems for environmental quality monitoring in freshwater catchments and marine and coastal areas. In addition, there is the requirement, as listed above, for monitoring and management of the marine environment. The Marine Environment Research Programme 2007–2013 will combine these elements to create Public Private Partnerships to develop novel products and services. These provide an opportunity for business development and can support the enhancement of Ireland's capability in marine environment research and monitoring.

### **Integrated Management and Advice**

The availability and reliability of marine environmental data is critical to assessing and managing the marine environment and promoting sustainable development. Existing and new data sets on key marine environmental variables need to be integrated, made accessible, and presented in formats that can be readily understood by all stakeholders. The review and analysis of such marine data sets will enable us to assess spatial and temporal changes at national and regional levels and to develop further insights into, and understanding of, marine ecosystems. These insights can form the basis for better policy advice and for management of marine resources.

### 4.1.3 2020 Vision

#### 2020 VISION

By 2020, Ireland will have healthy marine ecosystems that sustain and support a dynamic maritime economy. As part of its commitment to generating and applying knowledge for social and economic benefit, Ireland will have in place an integrated policy and regulatory system to ensure the sustainability of marine ecosystems while allowing for the rational use of marine resources.

National marine policy will be driven by an overarching goal to have healthy marine ecosystems that sustain indigenous biodiversity and provide for existing and new uses of marine and coastal resources.

Ireland will be fully compliant with the requirements of EU marine legislation and international conventions to which it is a contracting party, and will be able to demonstrate, through the compilation and regular publication of a suite of appropriate environmental assessments, the maintenance of a high quality marine environment.

Ireland will have developed a marine brand identity, with a high quality environment and robust economy. This brand will form part of a marketing programme for the seafood, tourism and other marine sectors.

#### 4.1.4 2013 Objectives

The following objectives have been identified as critical milestones to be achieved by 2013:

##### 2013 OBJECTIVES

- 1 Support the implementation, on a multi-agency basis, of environmental legislation, e.g.:
  - > Water Framework Directive;
  - > Proposed Marine Framework Directive;
  - > OSPAR Convention (1992);
  - > Environmental Impact Assessment Legislation (EIA & SEA Directives); and
  - > IMO Convention.
- 2 Support the sustainable development of marine resources and sectors through:
  - i) Establishment of a system of marine spatial planning and the introduction of a comprehensive system of ICZM;
  - ii) Identification of environmental indicators and development of sectoral Codes of Practice; and
  - iii) Measurement and mitigation of environmental impacts.
- 3 Enhance our understanding of marine and coastal ecosystems as a basis for environmental policy and sustainable resource management.
- 4 Support environmental and resource management and protection strategies, which will underpin an expanding marine based tourism and leisure sector.
- 5 Protect, maintain and, where necessary, enhance marine biodiversity.
- 6 Integrate data sets, carry out assessments, improve data availability and apply this science-based knowledge in policy-making and ecosystem management.
- 7 Develop stronger national collaborations (e.g. between lead agencies and research performers) and improved capabilities, methodologies and technologies for marine environmental monitoring.

#### 4.1.5 RTDI Requirements/Key Outputs

The identified RTDI requirements and key outputs for delivering on the 2013 Objectives of the research programme are presented below.

**Table 4.1** Research Requirements & Key Outputs for the Marine Environment to 2013

Objectives 2013	RTDI Requirements	Key Outputs
<p>1 Support the implementation, on a multi-agency basis, of environmental legislation.</p>	<p><b>Water Framework Directive</b></p> <ul style="list-style-type: none"> <li>&gt; Set reference conditions for coastal and transitional waters</li> <li>&gt; Carry out an inter-calibration of monitoring methodologies to ensure a standardised interpretation of ecological quality with EU member states</li> <li>&gt; Further develop ecological classification tools &amp; indicators</li> <li>&gt; Analyse current pressures and impacts on water quality and their future trends</li> <li>&gt; Develop and implement scientific monitoring tools to provide the data from key sectors (e.g. aquaculture, tourism and fisheries) necessary for development and implementation of sectoral 'Programme of Measures'</li> </ul> <p><b>EU Marine Strategy</b></p> <ul style="list-style-type: none"> <li>&gt; Research guidelines for implementation of the ecosystem approach in EU waters</li> <li>&gt; Set Environmental Quality Objectives appropriate for Irish waters</li> <li>&gt; Develop risk-based management techniques and use of scenarios for natural variability and human impacts</li> <li>&gt; Research methodologies to quantify the value, including non-market value, of marine resources</li> <li>&gt; Collaborate with other EU member states in co-ordinated marine monitoring activities</li> </ul> <p><b>Environmental Impact Assessment (EIA and SEA)</b></p> <ul style="list-style-type: none"> <li>&gt; Develop methodologies for screening and scoping plans and programmes</li> <li>&gt; Develop indicators to assess the cumulative impacts of individual marine developments</li> <li>&gt; Design and implement programmes to monitor the impacts of marine developments in order to identify unforeseen adverse effects on the environment</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Ireland published its River Basin Plans, including Programme of Measures, by June 2009 and is in a position to meet the main environmental objectives by 2015 in coastal and transitional waters in compliance with WFD (2000/60/EC)</li> <li>&gt; Intercalibration of monitoring methods successfully completed</li> <li>&gt; Set of ecological classification tools &amp; indicators developed and in use</li> <li>&gt; Monitoring programmes in place and data accessible to all stakeholders</li> </ul> <ul style="list-style-type: none"> <li>&gt; Ireland is in a position to shape the evolution of the EU Marine Strategy and any consequent legislation, e.g. Marine Framework Directive</li> <li>&gt; Conservation and management plans for human activities in the marine sector</li> <li>&gt; Environmental Quality Objectives (EQOs) for Irish waters developed and in use</li> <li>&gt; Adaptive management systems developed and in use</li> </ul> <ul style="list-style-type: none"> <li>&gt; Ireland is compliant with the progressive implementation of relevant EU Directives (e.g. SEA Directive—2001/42/EC).</li> <li>&gt; Key staff trained and the SEA methodology developed and adopted by state agencies for marine sectors.</li> </ul>

continued

Table 4.1 Research Requirements &amp; Key Outputs for the Marine Environment to 2013

Objectives 2013	RTDI Requirements	Key Outputs
	<p><b>OSPAR Convention</b></p> <ul style="list-style-type: none"> <li>&gt; Develop monitoring tools and quality objectives and standards for the broader OSPAR area</li> <li>&gt; Carry out thematic and holistic assessments of the state of the marine environment</li> <li>&gt; Improve methods to monitor and control hazardous substances in the marine environment</li> </ul> <p><b>IMO Convention</b></p> <ul style="list-style-type: none"> <li>&gt; Develop research and monitoring programmes to assess the environmental impacts of shipping, including the potential impacts of ballast waters at Irish ports</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Ireland is in a position to meet the OSPAR target (Article 6) of a joint assessment of the marine environment by 2010</li> <li>&gt; Irish ports and shipping sector has developed systems for the management of ballast water and adapts to meet IMO environmental guidelines</li> </ul>
<p>2 Support the sustainable development of marine resources and sectors through :</p> <p>i) Establishment of a system of marine spatial planning and the introduction of a comprehensive system of ICZM;</p>	<ul style="list-style-type: none"> <li>&gt; Develop the most appropriate methodologies for the preparation of a strategic multi-sectoral marine spatial plan in line with the developing requirements of the EU Maritime Policy and OSPAR</li> <li>&gt; Provide scientific input and co-ordinate the development of ICZM tools to meet local, national and EU requirements and obligations</li> <li>&gt; Design and interpretation of ICZM protocols</li> <li>&gt; Build spatially referenced databases of marine resources and activities</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Network of inshore and offshore SACs established by 2010</li> <li>&gt; ICZM protocols developed and in use in key areas</li> <li>&gt; ICZM plan for Ireland developed and incorporated in coastal zone planning</li> <li>&gt; Methodologies, objectives and targets for marine spatial planning</li> <li>&gt; Databases available and accessible to all stakeholders</li> </ul>
<p>ii) Identification of environmental indicators and development of sectoral Codes of Practice; and</p>	<ul style="list-style-type: none"> <li>&gt; Develop sustainability targets and environmental indicators for key marine sectors</li> <li>&gt; Research and develop Codes of Practice in collaboration with sectors</li> <li>&gt; Develop expertise in carrying capacity modelling for aquaculture</li> <li>&gt; Develop conceptual models for species/habitat interactions, e.g. in fisheries management</li> <li>&gt; Develop adaptive management systems for marine sectors</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Codes of Practice in use for main industry sectors, including aggregates, aquaculture, energy, fisheries, ports and shipping, and tourism</li> <li>&gt; Set of environmental indicators to manage the development, and measure impacts, of the use of marine resources</li> </ul>
<p>iii) Measurement and mitigation of environmental impacts.</p>	<ul style="list-style-type: none"> <li>&gt; Focused research on factors controlling the development, transport and impacts of Harmful Algal Blooms (HABs)</li> <li>&gt; Basic research on environmental quality stress factors such as zooplankton, particulate load, dissolved oxygen etc.</li> <li>&gt; Research on ecosystem effects of fishing</li> </ul>	<ul style="list-style-type: none"> <li>&gt; HAB forecasting models in use to ensure shellfish safety</li> <li>&gt; Appropriate conservation limits and practical mitigation measures adopted</li> <li>&gt; Early warning systems for harmful species (zooplankton)</li> <li>&gt; Science-based regulation of inputs to the marine environment</li> </ul>

continued

**Table 4.1** Research Requirements & Key Outputs for the Marine Environment to 2013

Objectives 2013	RTDI Requirements	Key Outputs
<p><b>3</b> Enhance our understanding of marine and coastal ecosystems as a basis for environmental policy and sustainable resource management.</p>	<ul style="list-style-type: none"> <li>&gt; Collect and collate adequate data (physical, chemical and biological) to establish baseline characteristics (including the dynamics) of marine and coastal environments</li> <li>&gt; Develop a comprehensive suite of physical circulation models for marine and coastal waters</li> <li>&gt; Establish knowledge of temporal and spatial variations in primary and secondary productivity in Irish waters</li> <li>&gt; Establish a suite of appropriate climate change indicators and assessment tools, e.g. models to enable the identification of climate change impacts/trends on the marine ecosystems and resources*. This could include ocean acidification as a related issue of emerging significance</li> <li>&gt; Improve the understanding of coastal erosion and develop appropriate responses (*See Section 3.5)</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Key data sets and databases in place and accessible to all relevant stakeholders</li> <li>&gt; Circulation models of marine and coastal waters, at appropriate spatial scales, developed and in use</li> <li>&gt; Improved understanding of potential impacts of climate change*</li> <li>&gt; Impacts of climate change considered in strategic planning of marine resource development*</li> <li>&gt; National coastal erosion and flood risk mapping and modelling system in place (* See Section 3.5)</li> </ul>
<p><b>4</b> Support environmental and resource management and protection strategies, which will underpin an expanding marine based tourism and leisure sector.</p>	<p>Based on existing coastal management initiatives at various locations around the coastline (e.g. 3rd level research projects), establish an inclusive partnership pilot project to inform the development of an Intergrated Coastal Zone Management (ICZM) strategy for Ireland. This should include:</p> <ul style="list-style-type: none"> <li>&gt; Analysis of current coastal management practice in Ireland and abroad</li> <li>&gt; Analysis and GIS mapping of current usage and trends at pilot sites (large and important bays for commercial fishing, tourism &amp; leisure including beaches, aquaculture and landside development)</li> <li>&gt; Analysis of key data on water quality, flora, fauna etc.</li> <li>&gt; Analysis of carrying capacities for each activity</li> <li>&gt; Analysis of conflicting resource uses</li> <li>&gt; Stakeholder consultation on needs and experience (through establishment of user forums)</li> <li>&gt; Opportunity mapping (GIS)</li> <li>&gt; Objective setting in agreement with stakeholders</li> <li>&gt; Analysis of environmental impacts &amp; socio-economic benefits</li> <li>&gt; Establishment of user research &amp; public education programmes on ICZM at a number of pilot sites</li> </ul> <p>Within the context of the Water Framework Directive, develop environmental indicators for rivers, lakes and coastal areas to support tourism</p>	<ul style="list-style-type: none"> <li>&gt; Integrated scientific insight into current coastal management practices, planning processes, carrying capacities and user conflicts</li> <li>&gt; Informed input to future government policy on licensing and regulation of the foreshore</li> <li>&gt; Informed input to regional, local and area waterside planning</li> <li>&gt; Heightened public awareness and understanding of coastal processes, environmental issues and use of the coastline for economic activities</li> <li>&gt; Informed input to management of tourism enterprises, e.g. angling and beaches</li> </ul>

continued

Table 4.1 Research Requirements &amp; Key Outputs for the Marine Environment to 2013

Objectives 2013	RTDI Requirements	Key Outputs
<p>5 Protect, maintain and, where necessary, enhance marine biodiversity.</p>	<ul style="list-style-type: none"> <li>&gt; Enhance surveys and research on marine biodiversity, through the implementation of a prioritised programme of surveys, mapping and assessment of marine species and habitats</li> <li>&gt; Develop a national marine biodiversity database</li> <li>&gt; Develop conservation objectives and targets for marine SAC Management Plans</li> <li>&gt; Produce conservation plans and define the status of threatened and vulnerable species and habitats.</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Marine aspects of the National Biodiversity Plan implemented</li> <li>&gt; Marine biodiversity database available to all stakeholders</li> <li>&gt; Conservation plans and objectives available for all marine SACs</li> <li>&gt; Status of threatened and vulnerable species known and conservation plans in place</li> </ul>
<p>6 Integrate data sets, carry out assessments, improve data availability and apply this science-based knowledge in policy-making and ecosystem management.</p> <p><i>(*See sections on Marine Technology and Knowledge &amp; Information Management).</i></p>	<ul style="list-style-type: none"> <li>&gt; Publish regular State of the Marine Environment reports, incorporating a suite of standard environmental performance indicators</li> <li>&gt; Establish integrated data management capabilities to extract greater value from routine monitoring activities</li> <li>&gt; Apply new technologies to data management and data visualisation</li> <li>&gt; Apply new analytical tools to marine environmental data</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Improved data accessibility and transparency</li> <li>&gt; Improved data interpretation, resulting in better management advice</li> <li>&gt; Ecosystem approach to management of marine resources adopted</li> </ul>
<p>7 Develop stronger national collaborations (e.g. between lead agencies and research performers) and improved capabilities, methodologies and technologies for marine environmental monitoring.</p>	<ul style="list-style-type: none"> <li>&gt; Implement agreed marine monitoring programmes and co-ordinated surveys as part of a multi-agency plan for the marine environment</li> <li>&gt; Develop a suite of environmental objectives, standards and indicators for use in marine environmental assessment and trend studies; including establishment and maintenance of long-term data sets</li> <li>&gt; Improve methodologies for detection and quantification of priority contaminants in water, sediments and biota</li> <li>&gt; Apply new technologies to marine environmental monitoring</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Regular reports on the state of the marine environment published, incorporating a suite of standard environmental performance indicators and key long-term environmental trends</li> <li>&gt; Novel monitoring tools and sensors in use</li> </ul>

### 4.1.6 RTDI Capacity/Capabilities

Marine environmental research draws on a wide range of disciplines within the research community and is carried out within the state, third-level and private sectors.

#### Current Research Capacity

##### Third-level Sector

Within the third-level sector, approximately 25 research groups carry out marine environmental research. Together, these research groups comprise approximately 160 researchers in marine environmental research (Table 4.2). The research focus of these groups/researchers covers a wide range of areas, reflecting the broad nature of the topic.

**Table 4.2** Overview of Current Marine Environment Research in the Third-level Sector

Institutes	No. Research Groups	No. Researchers*	Research Focus
NUIG UCC UCD CIT DIT WIT TCD GMIT	10 Large Groups 8 Medium Groups 7 Small Groups	161	<ul style="list-style-type: none"> <li>&gt; Marine conservation, ecology, biodiversity and ecosystem functioning</li> <li>&gt; Anthropogenic and natural processes controlling marine biodiversity</li> <li>&gt; Water quality assessment and modelling</li> <li>&gt; Molecular ecology</li> <li>&gt; Seabirds and marine mammals</li> <li>&gt; Sediment toxicity &amp; eco-toxicology</li> <li>&gt; Habitat mapping, deep ocean research</li> <li>&gt; Near shore and oceanic modelling</li> <li>&gt; Biological oceanography, bacterial community structure/biodiversity</li> <li>&gt; Aerosol and cloud physics, surface ocean-atmosphere interactions</li> <li>&gt; Management of fisheries resources</li> <li>&gt; Remote sensing/optical properties of marine waters</li> <li>&gt; Pollution and functioning of aquatic systems</li> <li>&gt; Climate change - impact modelling, sea level rise, biodiversity</li> <li>&gt; Sea level change.</li> <li>&gt; Coastal management, remote sensing, geomorphology</li> <li>&gt; Environmental and analytical chemistry</li> <li>&gt; Endocrine Disrupting Compounds (EDCs)</li> <li>&gt; Radiation biology and environmental toxicology</li> <li>&gt; Wind/Wave/SST data analysis</li> </ul>

Large: >10 researchers; Medium: 5–10 researchers; Small: <5 researchers

\* In some cases, a research group may focus on more than one theme and are larger than indicated here. The total number of researchers in the groups identified is approximately 250.

A further 30 groups are either a) involved in small-scale marine environmental research; b) currently applying their research skills/capabilities to niche areas of relevance to the marine environment; or c) have skills/technologies with potential applications to marine environmental research within the context of the identified RTDI requirements (Table 4.3). Many of these are in emerging areas such as advanced detection and analytical methods, environmental biotechnology and advanced sensor systems.

**Table 4.3** Additional Marine Environment Research Capacity and Potential in the Third-level Sector

Institute	Research Focus	Institute	Research Focus
UCC	<ul style="list-style-type: none"> <li>&gt; New detection platforms, optical O<sub>2</sub> sensing and respirometry</li> <li>&gt; Environmental toxicology</li> <li>&gt; Wind/Wave/Sea surface temperature data analysis</li> <li>&gt; Water quality monitoring technology</li> <li>&gt; Coastal zone management</li> </ul>	CIT	<ul style="list-style-type: none"> <li>&gt; Endocrine Disrupting Compounds (EDC) analysis</li> <li>&gt; Bioassays for detection of EDCs</li> <li>&gt; Water-borne pathogen analysis</li> </ul>
NUIG	<ul style="list-style-type: none"> <li>&gt; CZM policy and legislation</li> <li>&gt; Environmental legislation</li> </ul>	UL	<ul style="list-style-type: none"> <li>&gt; Deployed sensors</li> <li>&gt; Estuarine plant ecology</li> </ul>
UCD	<ul style="list-style-type: none"> <li>&gt; Microbial water quality</li> <li>&gt; Remote sensing and the measurement of optical properties of marine waters</li> </ul>	IT Carlow	<ul style="list-style-type: none"> <li>&gt; Advanced analytical /surveillance technologies</li> <li>&gt; Biosensors</li> <li>&gt; Microbial metal resistance</li> </ul>
TCD	<ul style="list-style-type: none"> <li>&gt; Water quality modelling, coastal design</li> <li>&gt; Sensor nodes for water quality monitoring</li> </ul>	Sligo IT	<ul style="list-style-type: none"> <li>&gt; Analytical chemistry</li> <li>&gt; Marine, ecology, biology and biodiversity</li> </ul>
DCU	<ul style="list-style-type: none"> <li>&gt; Environmental sensors, analytical chemistry</li> <li>&gt; Digital Image Analysis-marine sediment profiling</li> <li>&gt; Environmental monitoring and modelling</li> <li>&gt; Environmental biotechnology</li> </ul>	DIT	<ul style="list-style-type: none"> <li>&gt; Radiation biology and environmental toxicology (toxicity of sediments)</li> </ul>
GMIT	<ul style="list-style-type: none"> <li>&gt; Climate change impacts on fish and invertebrate distribution and population dynamics</li> </ul>	Athlone IT	<ul style="list-style-type: none"> <li>&gt; Ecotoxicological and cytotoxicological assessment of xenobiotics</li> <li>&gt; In vivo and in vitro assessment of EDCs</li> </ul>
WIT	<ul style="list-style-type: none"> <li>&gt; Separation science</li> <li>&gt; Estuarine research, bioremediation</li> <li>&gt; Novel detection/analytical methodologies</li> <li>&gt; Telemetry</li> </ul>	Limerick IT	<ul style="list-style-type: none"> <li>&gt; Environmental sensing systems (petroleum hydrocarbons, EDCs)</li> </ul>

### State Sector

A number of state agencies and government departments are actively involved in marine environmental research and monitoring and have the capacity to contribute to the future RTDI requirements:

- > Marine Institute staff (~ 20 staff) carry out research programmes that include both Irish and internationally funded research projects (e.g. habitat mapping and trophic status assessment methods), and partner third-level institutes in a number of NDP Marine RTDI-funded projects (e.g. HABS research).
- > Department of Environment, Heritage & Local Government (National Parks & Wildlife Service) has research expertise in the area of marine biodiversity and conservation.
- > Enterprise Ireland has expertise in the area of Integrated Coastal Zone Management.
- > Staff in the Environmental Protection Agency (EPA) carry out monitoring work in estuarine and near shore waters.
- > Met Éireann have research expertise in the fields of marine weather forecasting and modelling and climate change modelling.
- > Radiological Protection Institute of Ireland (RPII) staff monitor and carry out research relating to radioactive substances in the marine environment.

In addition, staff in a number of coastal local authorities collaborate in research relating to coastal protection and ICZM.

### Industry

A small number of marine environmental consultants (both companies and individuals) participate in nationally and internationally funded research programmes and have expertise in a number of areas that can be applied to the identified RTDI requirements. Areas of expertise within these companies include invasive species, biodiversity, environmental surveying and monitoring, taxonomy, water quality and inshore and offshore modelling.

### Identification of Research Skills/Competencies to Meet Future RTDI Requirements

A summary, based on the identified future RTDI requirements, of the competencies required to meet the 2013 Objectives is presented in Table 4.4. Also included in Table 4.4 is an assessment of whether there are current strengths (S), areas that require strengthening (R), or gap areas (G), in relation to the identified requirements, within the existing research community.

Table 4.4 Competencies Required to Meet Future Research &amp; Innovation Requirements for the Marine Environment

Objectives 2013	Competencies Required	Assessment
1 Support the implementation, on a multi-agency basis, of environmental legislation.	<ul style="list-style-type: none"> <li>&gt; Environmental assessment</li> <li>&gt; Risk assessment techniques and scenario modelling</li> <li>&gt; Development/adaptation of sustainability, environmental and conservation targets and indicators</li> <li>&gt; Design and implementation of monitoring programmes for activities and developments</li> <li>&gt; Socio-economics (assessment of value)</li> </ul>	<ul style="list-style-type: none"> <li>S</li> <li>G</li> <li>R</li> <li>R</li> <li>G</li> </ul>
2 Support the sustainable development of marine resources and sectors through: <ul style="list-style-type: none"> <li>i) Establishment of a system of marine spatial planning;</li> <li>ii) Identification of environmental indicators and development of sectoral codes of practice; and</li> <li>iii) Measurement and mitigation of environmental impacts.</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Fundamental marine sciences</li> <li>&gt; Marine spatial planning and ICZM</li> <li>&gt; Data handling, analysis and management (including GIS)</li> <li>&gt; Development of management systems/codes of practice</li> <li>&gt; Carrying capacity models</li> <li>&gt; Development/adaptation of sustainability, environmental and conservation targets and indicators</li> <li>&gt; Ecosystem modelling</li> <li>&gt; Remote monitoring and prediction of HABS</li> <li>&gt; Assessment of fisheries-environment interactions</li> </ul>	<ul style="list-style-type: none"> <li>S</li> <li>G</li> <li>R</li> <li>R</li> <li>G</li> <li>R</li> <li>R</li> <li>R</li> </ul>
3 Enhance our understanding of marine and coastal ecosystems as a basis for environmental policy and sustainable resource management.	<ul style="list-style-type: none"> <li>&gt; Fundamental marine sciences</li> <li>&gt; Physical modelling</li> <li>&gt; Offshore and coastal dynamics and coastal processes</li> <li>&gt; Development/adaptation of climate change indicators</li> </ul>	<ul style="list-style-type: none"> <li>S</li> <li>R</li> <li>R</li> <li>R</li> </ul>
4 Support environmental and resource management and protection strategies, which will underpin an expanding marine based tourism and leisure sector.	<ul style="list-style-type: none"> <li>&gt; Environmental assessment</li> <li>&gt; Socio-economics (assessment of value)</li> <li>&gt; Data handling, analysis and management (including GIS)</li> <li>&gt; Carrying capacity models</li> <li>&gt; Development/adaptation of sustainability, environmental and conservation targets and indicators</li> </ul>	<ul style="list-style-type: none"> <li>S</li> <li>G</li> <li>R</li> <li>G</li> <li>R</li> </ul>
5 Protect, maintain and, where necessary, enhance marine biodiversity.	<ul style="list-style-type: none"> <li>&gt; Fundamental marine sciences</li> <li>&gt; Habitat mapping</li> <li>&gt; Species identification and taxonomic skills</li> <li>&gt; Data handling, analysis and management</li> <li>&gt; Development/adaptation of sustainability, environmental and conservation targets and indicators</li> </ul>	<ul style="list-style-type: none"> <li>S</li> <li>S</li> <li>G</li> <li>R</li> <li>R</li> </ul>

continued

**Table 4.4** Competencies Required to Meet Future Research & Innovation Requirements for the Marine Environment

Objectives 2013	Competencies Required	Assessment
6 Integrate data sets, carry out assessments, improve data availability and apply this science-based knowledge in policy-making and environmental management.	<ul style="list-style-type: none"> <li>&gt; Indicator-based environmental assessment</li> <li>&gt; Data handling, analysis and management</li> <li>&gt; Data visualisation</li> </ul>	<p>R</p> <p>R</p> <p>R</p>
7 Develop stronger national collaborations and improved capabilities, methodologies and technologies for marine environmental monitoring.	<ul style="list-style-type: none"> <li>&gt; Development/adaptation of sustainability, environmental and conservation targets and indicators</li> <li>&gt; Data handling and analysis</li> <li>&gt; Advanced detection and analysis methodologies</li> <li>&gt; Advanced monitoring technologies (e.g. deployed sensors)</li> </ul>	<p>R</p> <p>R</p> <p>R</p> <p>G</p>

\* S – Current Strength; R – Requires Strengthening; G – Gap Area.

There is clearly a large body of researchers in all sectors (state, third-level and private) involved in many aspects of marine environmental research. However, much of the research effort is fragmented and although disciplines and skills may be present within research teams, they need to be targeted and applied to specific RTDI requirements in order to meet the overall objectives. Furthermore, a number of research groups within the third-level sector carry out research that, although not directly marine-related, has potential for application to the marine sector. This is particularly the case in emerging areas such as advanced detection and analytical methods, environmental biotechnology and advanced sensor systems. Coherent research programmes would provide the catalyst to orient the focus of many of these teams towards the RTDI requirements for the marine environment.

Gaps exist in areas such as ecological modelling, taxonomy, advanced monitoring technologies and the application of socio-economics to marine resources (including non-market value). Competencies exist in the areas of marine spatial planning and ICZM. However, the practical application of these tools is weak.

Current Strengths	Require Strengthening	Gaps
<ul style="list-style-type: none"> <li>&gt; Fundamental marine sciences</li> <li>&gt; Habitat mapping</li> <li>&gt; Environmental assessment</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Design and implementation of monitoring programmes for activities and developments</li> <li>&gt; Data handling, analysis, management and visualisation (including GIS)</li> <li>&gt; Development of management systems/codes of practice</li> <li>&gt; Indicator-based environmental assessment</li> <li>&gt; Development/adaptation of sustainability, environmental and conservation targets and indicators</li> <li>&gt; Development/adaptation of climate change indicators</li> <li>&gt; Remote monitoring and prediction of HABS</li> <li>&gt; Assessment of fisheries-environment interactions</li> <li>&gt; Physical modelling</li> <li>&gt; Offshore and coastal dynamics and coastal processes</li> <li>&gt; Advanced detection and analysis methodologies</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Marine spatial planning and ICZM</li> <li>&gt; Carrying capacity models</li> <li>&gt; Ecosystem modelling</li> <li>&gt; Species identification and taxonomic skills</li> <li>&gt; Advanced monitoring technologies (e.g. deployed sensors)</li> <li>&gt; Socio-economics (assessment of value)</li> <li>&gt; Scenario modelling</li> </ul>

Figure 4.1 Research Competencies Required to Meet 2013 Objectives for Marine Environment

#### 4.1.7 Prerequisites for Achieving Objectives

There a number of prerequisites for the successful delivery of the 2013 Objectives for the marine environment research programme:

- > A National Marine Policy, aligned to and consistent with EU Marine Policy, together with a coherent set of sectoral policies that recognize the critical role played by the marine and coastal environment;
- > Adoption of marine spatial planning tools, building on the available legislative systems;
- > Implementation of an agreed national, multi-agency, marine environmental monitoring programme and marine spatial planning;
- > Stakeholder and public awareness, understanding and appreciation of the intrinsic value of the marine and coastal environment;
- > A new generation of marine scientists and engineers supported by appropriate training programmes and career structures; and
- > Availability of state-of-the-art platforms, equipment/instrumentation and laboratory infrastructure, e.g. sensors and telemetry systems.