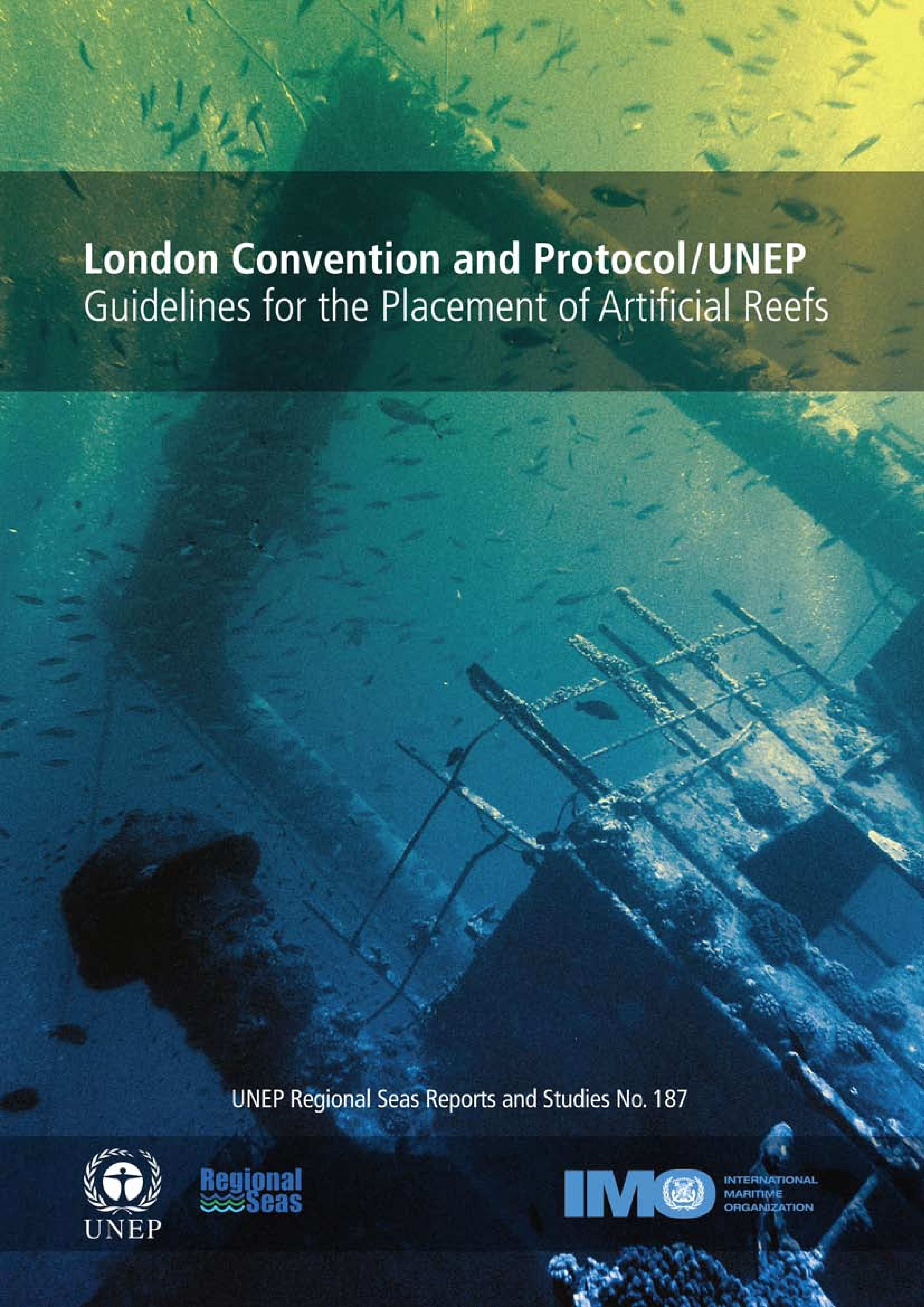
London Convention and Protocol/UNEP
Guidelines for the Placement of Artificial Reefs



UNEP Regional Seas Reports and Studies No. 187

UNEP

Regional Seas

INTERNATIONAL MARITIME ORGANIZATION

London Convention and Protocol/UNEP

Guidelines for the Placement of Artificial Reefs

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United Nations Environment Programme

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IMO

INTERNATIONAL MARITIME ORGANIZATION

Published in 2009
by the International Maritime Organization
4 Albert Embankment, London SE1 7SR

Printed in the United Kingdom by CPI Books

ISBN: 978-92-807-3022-7
Job No. DEP/1167/CA

For bibliographic purposes this document may be cited as: London Convention and Protocol/UNEP (2009). *London Convention and Protocol/UNEP Guidelines for the Placement of Artificial Reefs*. London, UK, 100 pp.

Foreword

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It is a well known fact that artificial reefs have been used in many regions across the world throughout the ages. There is evidence, for instance, that such reefs were being used in the Mediterranean Sea some three millennia ago, when rocks discarded from the *tonnaria* tuna fishery 'net cages' accumulated over time, to become fish aggregation sites. It is likely that similar artisanal fisheries used this technology in Australasia, as fish traps have been identified along the coastline of Australia.

During the 1600s artificial reefs of building rubble and rocks were used in Japan to grow kelp, where the modern "Artificial Reef" concept comes from. It spread to the United States in the 1830s, when logs from huts were used off the coast of South Carolina to improve fishing, and subsequently to many different areas of the world (Stone *et al*, 1991).

More recently, artificial reefs have been deployed to counteract alarming trends in the degradation of coastal waters, losses in sub-tidal habitats and plunging fish stocks. Such reefs are constructed or placed on the sea-bed to mimic some functions of a natural reef. So with time, other uses of artificial reefs have emerged and developed, such as the promotion of tourism (diving, boating and fishing); the enhancement and production of living marine resources; aquaculture; biodiversity management; scientific research; erosion control and shoreline stabilization and costal defense.

The escalating use of artificial reefs in coastal areas, combined with the possibility that they may have negative consequence has given rise to the need for some form of global guidance with regard to their construction, deployment and ongoing management. Contracting Parties to the global treaty instruments preventing pollution from dumping of wastes (London Convention 1972 and its 1996 Protocol) and member States of the United Nations Environment Programme have been particularly concerned that the inappropriate placement of such reefs could be used to legitimize the *dumping* of waste or other materials which would normally be prohibited under these treaties.

Hence, one of the primary objectives of these Guidelines is therefore to ensure that the development of artificial reefs is consistent with the aims and provisions of the London Convention and its Protocol and is carried out in harmony with the basic principles of the ecosystem approach to the management of the marine environment.

These Guidelines are thus intended to assist:

- those countries that have recognized the need to assess proposals for the placement of artificial reefs on the basis of scientifically sound criteria, as well as to develop an appropriate regulatory framework;
- with the implementation of regulations in those countries where such regulations are already in place, but where there is nevertheless a need for guidance; and
- in updating existing guidelines or regulations.

We hope that these extensive Guidelines will encourage greater awareness of the importance of well planned, properly designed and suitably placed artificial reefs and the benefits for the marine environment that they can generate.

We would like also to thank the Government of Spain for taking a lead role, together with many other countries in the Correspondence Group during the development of these guidelines under the London Convention and Protocol.

Finally, we are proud of the excellent cooperation between the Division of Environmental Policy Implementation of UNEP and the Secretariat of the London Convention and Protocol in the Marine Environment Division of IMO who worked closely together when identifying the need for and developing this important guidance. It greatly expands our toolbox to assist in the mitigation and recovery of degraded habitats and ecosystems and ensuring artificial reefs are placed in accordance with sound marine resource management principles.

Acknowledgements

This publication came to being as a result of considerable financial and in-kind contributions from the United Nations Environment Programme (UNEP), the Technical Co-operation and Assistance Programme under the London Convention and Protocol (LC/LP), the Governments of Spain and the United States.

Special thanks go to Dr. Ellik Adler (UNEP), Mr. José Buceta Miller (Spain, Chair of the LC/LP Correspondence Group on Artificial Reefs (CGAR)), members of the CGAR (Mr. Juan J. Goutayer, Spain; Ms Jennifer Winston and Mr. Jeremy Martinich, United States; Mr. Matthew Johnston, Australia; Ms Dixie Sullivan and Mr. David Taillefer, Canada; Mr. Kjeld F. Jørgensen and Mr. Stig A. Helmig, Denmark; Ms Katja Bunzel and Mr. Ulrich Claussen, Germany; Mr. Sadamitsu Akeda and Mr. Akito Sato, Japan; Dr. Gi Hoon Hong, Republic of Korea; Mrs. Piyarat Pitiwatanakul, Thailand; Dr. Chris Vivian, United Kingdom; Dr. David Santillo, Greenpeace International; Dr. John Campbell, International Association of Oil and Gas Producers), Mr. René Coenen, Mr. Edward Kleverlaan and Ms Jennifer Rate (IMO - Office for the London Convention and Protocol) and Mr. Mark Combe (IMO - Publications).

Additionally, the following specialists played a key role in the development of the document: Dr. Francisco Gonzalez, Consultant/Technoambiente, Spain, Dr. Antony Jensen and Dr. Ken Collins, Consultants/ National Oceanography Centre, Southampton, University of Southampton.

Finally, particular thanks go to Dr. Lynette Jackson, Environmental Consultant/Editor, who reshaped and edited the final manuscript.

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1. *An Introduction to Artificial Reefs*

1.1 Background

Artificial reefs are used for coastal management purposes in many countries and regions across the world, and are thought to have developed in parallel in a variety of locations. There is evidence that reefs were being used in the Mediterranean Sea three millennia ago, when rocks discarded from the *tonnaria* tuna fishery 'net cages' accumulated over time and were recognised as fish attraction structures (Riggio *et al,* 2000). It is likely that similar artisanal fisheries were using this technology world wide at the same time (Simard, 1995).

During the 1600s reefs of building rubble and rocks were used in Japan to grow kelp, and the modern "Artificial Reef" concept comes from XVIII century Japan. It spread to the USA in the 1830s, when logs from huts were used off the coast of South Carolina to improve fishing, and subsequently to many different areas of the world (Stone *et al,* 1991). More recently, reefs have been used to protect marine resources from illegal fishing activities (Jensen *et al,* 2000).

The escalating use of artificial reefs in coastal areas, combined with the possibility that they may have negative consequences – especially when waste, recycled or unsuitable materials are used - has given rise to the need for some form of guidance with regard to their construction, deployment and ongoing management. Contracting Parties to the London Convention (1972) and the London Protocol (1996) have been particularly concerned that the placement of such reefs could be used to legitimise the "dumping" of waste or other materials which would normally be prohibited under the Convention.[1] One of the primary objectives of these Guidelines is therefore to try and ensure that the development of artificial reefs is consistent with the aims and provisions of the Convention.

1.2 Purpose and Scope of the Guidelines

The installation of artificial reefs can be considered to be <u>placement under the terms of the Convention or Protocol, rather than dumping, provided such placement is not contrary to the aims of the Convention</u> or Protocol (see section 2.1.1 for further details). Although these guidelines have been developed within the context of the London Convention and Protocol, they are, as is true for any guidelines, not legally binding on any country, whether or not it has existing national regulations. The purpose of the Guidelines is to:

- assist those countries that have recognised the need to assess proposals for the placement of artificial reefs on the basis of scientifically sound criteria, as well as to develop an appropriate regulatory framework;
- assist with the implementation of regulations in those countries where such regulations are already in place, but where there is nevertheless a need for such guidance;
- assist in updating existing guidelines or regulations.

[1]For purposes of these guidelines, references to the London Convention - or just Convention – unless stated otherwise, should be considered to include both the London Convention and the London Protocol.

The guidelines may also be of use:

1. to proponents of artificial reefs in as much as they will assist them in understanding the criteria against which their proposals will be evaluated; and
2. in managing the placement of a range of other coastal management structures with characteristics similar to artificial reefs, and with the potential to cause adverse effects in the marine environment.

The broader objectives of the Guidelines are:

- to prevent pollution or degradation of the marine environment as a consequence of the placement of artificial reefs;
- to ensure that placement of artificial reefs is not used as a mechanism to circumvent the provisions of the London Convention on the "dumping" of waste;
- to promote an approach to artificial reef development such that even where a reef is built primarily for commercial purposes (fisheries, tourism etc), it nevertheless has environmental benefits.

The Guidelines will achieve the above by:

- providing information of the different purposes and types of artificial reefs in use world-wide, as well as on their potential impacts;
- providing an overview of relevant international legal requirements/regimes (eg. London Convention), as well as examples of regional agreements and national regulations;
- outlining a framework within which regulatory authorities and/or managers can make scientifically and technically sound decisions on the placement of artificial reefs;
- providing practical, technical information on the planning, design, materials, siting, monitoring and ongoing management of artificial reefs to support a scientifically-based approach to decision-making.

1.3 Definition of Artificial Reefs

Different countries – and regions – have different definitions of artificial reefs. In order to promote a common understanding of the term, the following definition has been adopted for purposes of these Guidelines, and to serve as a model definition:

> *"An artificial reef is a submerged structure deliberately constructed or placed on the seabed to emulate some functions of a natural reef such as protecting, regenerating, concentrating, and/or enhancing populations of living marine resources.*
>
> *Objectives of an artificial reef may also include the protection, restoration and regeneration of aquatic habitats, and the promotion of research, recreational opportunities, and educational use of the area.*
>
> *The term does not include submerged structures deliberately placed to perform functions not related to those of a natural reef - such as breakwaters, mooring, cables, pipelines, marine research devices or platforms - even if they incidentally imitate some functions of a natural reef."*

1.4 Overview of the purposes and types of artificial reefs in coastal waters

Artificial reefs have been placed in coastal waters for a variety of purposes. Accordingly, there are also a variety of designs, with many being purpose-built to enable them to perform the intended function. On the other hand, in some countries reefs have been constructed from structures originally built for another purpose but which have become obsolete or disused and are therefore available for reef construction.

Purpose-built reefs are generally for production or protection purposes. In the case of production reefs, the modules are alveolar, of various shapes, and, in some cases, are piled on top of one another. This allows the reef to have an appropriate amount of surface area available for the establishment of settling organisms, as well as sufficient cavities for free-living species. They can be constructed of, for example, concrete, ceramic materials or a matrix of PVC and concrete. There have also been cases where waste materials such as coal ash, or ash from incinerators, have been combined with cement to create reef modules.

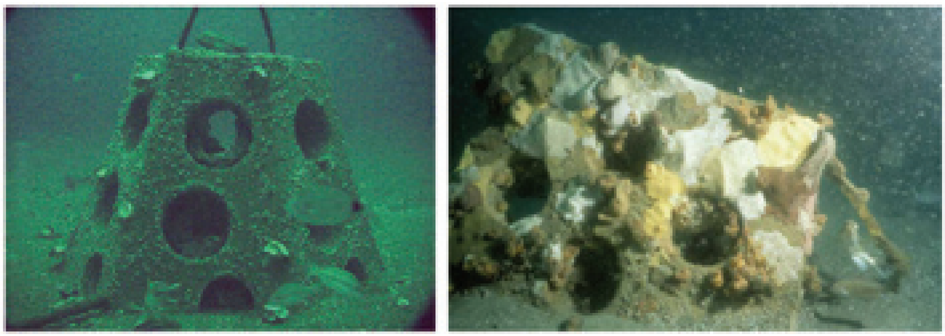

Fig 1.4.1. – *Artificial reef designs to provide habitat for marine organisms*
(Source: *Robert Martore, South Carolina Department of Natural Resources).*

In contrast, protection reefs tend to be built of heavy, relatively plain, modules – such as concrete blocks of various designs – often with deterrent arms, and not intended to promote settlement or occupation.

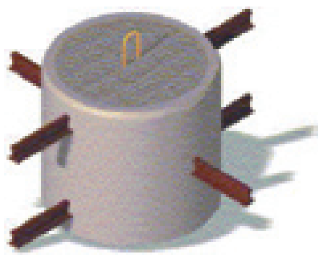

Fig 1.4.2. – *Module design for an artificial reef (with deterrent arms) for the protection of habitat against illegal fishing activities*
(Source: *General Secretariat of the Sea, Spain).*

The most common opportunistic structures used to construct reefs are ships – including both wrecks, and vessels deliberately sunk for this purpose. Other structures which have been used include oil and

Fig 1.4.3. – *Tram cars being loaded for placement as an artificial reef (left), and part of an airplane used as an artificial reef*
(Source: *Robert Martore, South Carolina Department of Natural Resources).*

gas platforms, planes, motor car bodies, train carriages and abandoned piers etc., although there is not general agreement on their acceptability. Natural rocks have also been used, although more frequently in the construction of breakwaters for coastal protection purposes, rather than for artificial reefs. In the past, tyres were also used to create reefs in a number of countries. Such reefs are, however, highly unstable over time, do not achieve their purpose, and may contribute to degradation of the marine environment.

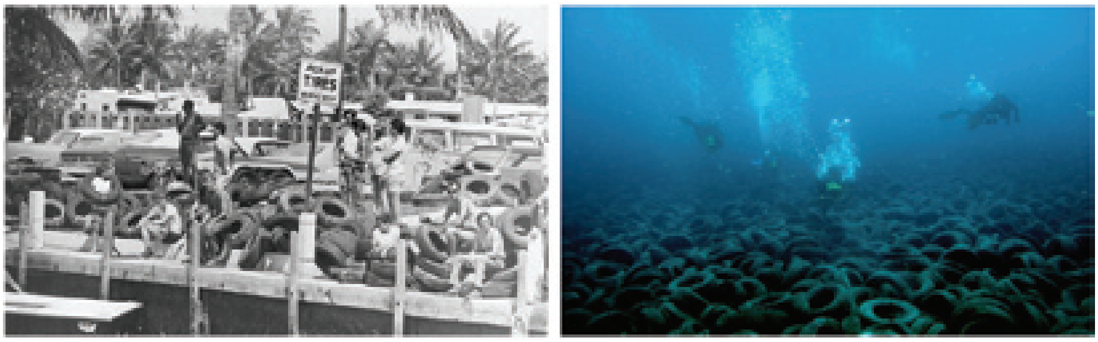

Fig. 1.4.4. – *Tyres being collected for an artificial reef project in Florida (left), and smothering coral reefs (right)*
*(*NOTE: *the tyres have subsequently been removed).*
*(*Source: *http://www.dep.state.fl.us/waste/categories/tires/pages/osbornepilot.html).*

For purposes of this overview, artificial reefs have been grouped into several categories based on their functions as outlined below:

1.4.1 Environmental purposes (biodiversity or ecosystem management, restoration, water quality management etc)

One of the primary objectives of coastal management should be to **prevent** the degradation of natural habitats, ecosystems and biodiversity. Where this has failed, the first choice in terms of potential interventions should be to reduce the pressures causing the degradation, so as to allow the system to recover naturally. Only where such efforts are not successful, should the deployment of artificial reefs be considered.

Nevertheless, artificial reefs are sometimes constructed with a view to increasing or altering **biodiversity**, for example:

- Reefs placed on sandy, underwater plains introduce hard substrates and the associated biota to areas where none were present before (although it is important to note that the introduction of hard substrata onto a sandy plain may not be considered by all stakeholders as an enhancement of biodiversity, as it can lead to the loss of those species associated with sandy bottoms);
- Reefs can be specially designed to maximise the variety and quantity of epibiotic colonisation by including a large number and diversity of niche sizes;
- Reefs can also be designed to take advantage of the 'edge effect' (most sedentary biota seem to choose an edge for settlement, presumably to maximise their exposure to water flow).

The objectives of such reefs can be i) just a general increase in epibiotic biomass (as well as the associated mobile fauna); ii) the creation of a 'conservation hotspot' within say a marine reserve; iii) the re-establishment of biological communities after a damaging event such as a hurricane or pollution incident; or iv) compensation for habitat loss elsewhere – the 'mitigation' reef concept.

Where artificial reefs are used in the **restoration** of specific marine habitats, it is important that the materials used are, as far as possible, natural materials similar to the original ones. Moreover, such initiatives need to be very carefully considered, especially where complex and sensitive habitats are concerned.

In the case of coral reefs, for example, artificial reefs are considered to be appropriate only under very specific circumstances, such as for small areas of coral reefs of particular economic value, or following maritime accidents or natural disasters.[2]

Materials used for coral reef restoration include limestone boulders, or modules made of concrete (eg. ReefBalls) or ceramic materials (eg. EcoReefs). But, as stated in the guidelines produced under the Coral Reef Targeted Research Programme:[3] *"There are estimated to be in excess of 500,000 "reef balls" of varying size deployed worldwide. These will provide at most a couple of square kilometres of topographically complex substrata as a cost of US$ tens of millions. There are an estimated 300,000 km^2 of shallow coral reefs in the world, so there is plenty of substrate available. The main problem is that much of it is poorly managed or degraded."*

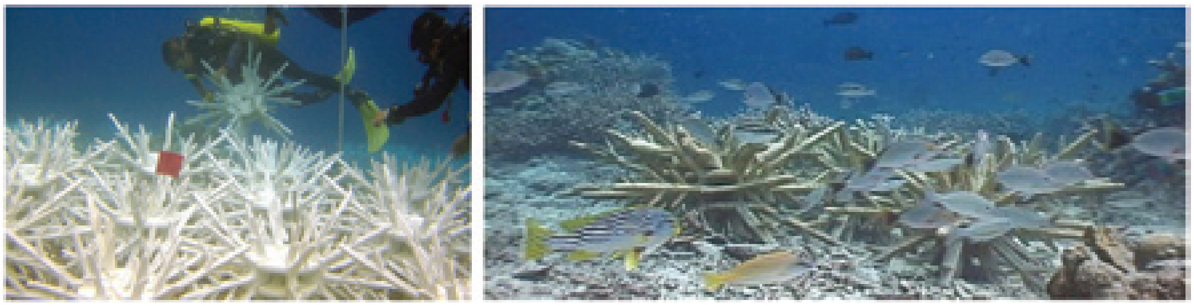

Fig. 1.4.5. – *Modules used for coral reef restoration being placed by divers (left), and after about 70 days (right)*
*(*Source: *www.ecoreefs.com).*

Protection reefs with deterrent elements have also been used as a means to reduce or eliminate pressures on some ecosystems – such as illegal fishing activities – thereby allowing them the opportunity to recover naturally. For example, a number of anti-trawling reefs deployed in the western Mediterranean have led to recovery of meadows of the seagrass *Posidonia oceanica.*

"Mitigation" reefs are normally considered where a coastal development or operation is in the overwhelming interest of a province, state or country and where damage to a natural reef or habitat is unavoidable. For example, a 61 hectare artificial reef has been proposed in Southern California to compensate for the loss of kelp beds lost as a result of the operations of the San Onofre Nuclear Generating Station. To date, an experimental reef of 9 hectares has been established.

Artificial reefs have also been used in the management of **water quality** in the vicinity of aquaculture facilities, in particular in the finfish farming industry, where large amounts of organic material can accumulate below the cages. The structures provide a substrate for the settlement of benthic species which then act as biofilters, and have been used widely, from Hong Kong, China to Poland, Finland, Israel, Chile and Canada. They include "extensive biofilters" – which utilise natural communities – as well as "intensive biofilters", where the reefs are seeded with species of commercial value, and which can not only also be harvested, but provide more predictable filtration rates. This co-cultivation of species of different trophic levels is known as integrated, multi-trophic aquaculture.[4] It should be noted that, although these biofilters are referred to as artificial reefs in the scientific literature, they serve a rather different function than those outlined in the definition of artificial reefs adopted for purposes of this document (see section 1.3 above).

[2]For further information see: ICRI Resolution on Artificial Coral Reef Restoration and Rehabilitation. Available at: http://www.icriforum.org/library/ICRI_resolution_Restoration.pdf.

[3]A. Edwards & E. Gomez (2007) *Reef Restoration Concepts and Guidelines: making sensible management choices in the face of uncertainty*. CRTR Programme, St. Lucia, Australia. 38pp. Available at: http://www.gefcoral.org/InformationResources

[4]Angel, D.L. (2004). *Integrated Multi-trophic Aquaculture - Variations on the Theme of Biofiltration*. Bull. Aquacul. Assoc. Canada 104 (3): 54 – 59.

Fig. 1.4.6. – *A reef as a substrate for mussel cultivation*
(Source: *Gianna Fabi, CNR Ancona).*

1.4.2 Living marine resources: attraction, enhancement, production and protection

Artificial reefs can be used for a variety of purposes in relation to the utilisation of living marine resources including concentrating them in particular areas, increasing biological productivity, production of target species, and protection against illegal fishing activities. The overall objective of such reefs should be to promote sustainable utilisation of the resource.

Artificial reefs may **increase the biomass** – and therefore availability - of specific commercial fish species, by enhancing their survival, growth and reproduction. This is achieved by increasing their preferred habitat/s, including spawning grounds, feeding grounds, hiding and resting places, and should cater for the requirements of both adults and juveniles. Such reefs are obviously of greatest benefit when applied to species that use hard substrates for shelters or spawning sites, and/or which feed on reef epibiota (or associated species).

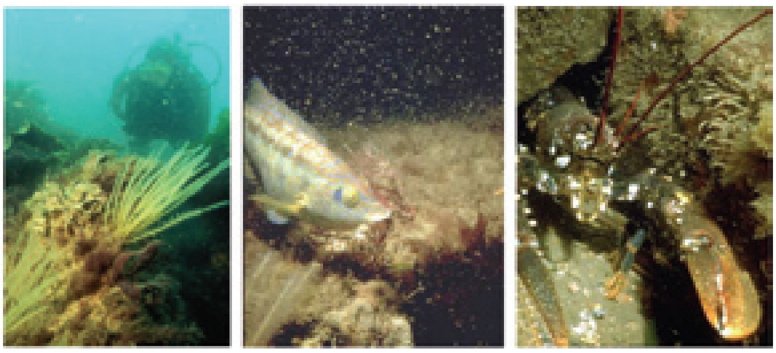

Fig. 1.4.7. – *Epifauna (left), nest building fish (Crenilabrus melops) (centre) and lobster on a cement stabilised fly ash reef unit (right)*
(Source: *left & centre: Antony Jensen, NOC; right: Ken Collins, NOC).*

Structures used for this purpose have become highly sophisticated, particularly in the context of aquaculture. They comprise a variety of designs and can be constructed with a number of different materials, depending on the habitat that is required. Reefs can be designed to accommodate several species (by incorporating a diversity of niches in terms of shape and size) or they can be species specific, focusing on the habitat required by the targeted species. Design options include cell or alveolar, mixed, matrix, or lattice structures.

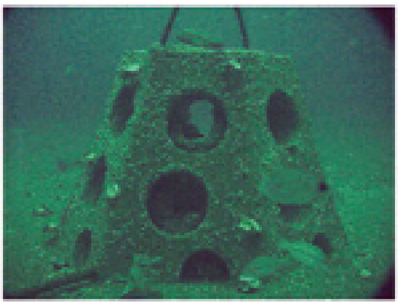
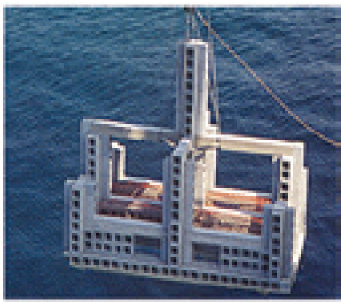

Fig. 1.4.8. – *Concrete structures with cell openings*
(Source: *left: Robert Martore, South Carolina Department of Natural Resources; right: J. Goutayer, Spain).*

Artificial reefs can also be used to **concentrate** certain fish in a particular location. Although such reefs do not generally contribute significantly to the biological productivity of the ecosystem, since they do also attract other species – benthic and planktonic – they do increase biological richness. However, attraction reefs act as fishing traps, making it easier for fishermen to catch them. Their indiscriminate use can, therefore, contribute to the over-exploitation of the resource, and they should only be promoted within the framework of an appropriate fisheries management system.

Such attraction reefs are commonly used for recreational purposes, but also play an important role in artisanal fisheries in that:

- known harvesting locations contribute to the security of the harvest;
- locations close to the coast improve the safety of fishers using small craft.


Fig. 1.4.9. – *Ferroconcrete artisanal fishery reef units, Kerala, southern India*
(Source: *left: Alternative Technology; right: Antony Jensen, NOC).*

Fishermen in Kerala, south-west India, for example, use ferro-concrete tents as fish attraction devices. In general, in these areas, fishing techniques are inefficient and do not endanger commercial stocks.

Modular structures built of concrete, weighing up to 8 tonnes, and with elements designed to hook trawl nets have been deployed in some areas to act as a **deterrent** to illegal trawling activities (see Fig. 1.4.2 above).

1.4.3 Promotion of tourism and leisure activities (angling, SCUBA diving, surfing, boating etc)

Many artificial reefs have been developed to attract SCUBA divers and recreational anglers. To ensure maximum benefit, diving reefs should be visually attractive and interesting and should preferably support a profusion of marine life. Sunken ships (or sections of vessels) are often used to create diving reefs (see Fig. 1.4.3 above) as most divers find ship wrecks interesting, but as mentioned above, many other previously used structures and materials have also been deployed for this purpose, with varying success.

Artificial reefs intended just to attract and concentrate fish populations do not necessarily contribute significantly to the biological productivity of the ecosystem. Rather they are intended to make it easier for anglers to catch the fish. They can therefore be constructed with a range of materials, provided they meet regulatory requirements, provide a suitable habitat for the fish, some substrate for the settlement of benthic organisms, and do not degrade the environment.

Artificial reefs for diving or angling can also contribute to the conservation of natural reefs by providing relief from diving or fishing pressure on some of the surrounding natural reefs. This is especially important for biogenic structures such as coral reefs.

It is important to note that SCUBA diving and recreational angling do not mix well: divers disturb fish and hooks potentially can hurt divers. Coastal managers should therefore consider designating specific reefs – or parts thereof - for one or other activity.

Reefs can also be especially designed with the purpose of producing 'wave breaks' for surfers, at a specific distance from the coast line. This technology derives from New Zealand and Australia and is being adopted globally to improve surfing conditions for tourists.

1.4.4 Scientific research and education

Artificial reefs can also play a part in scientific research and education. Scientific objectives can include:

- assessment of physical, chemical, biological and socio-economic impacts;
- assessment of the efficacy of reef unit designs;
- assessment of the environmental acceptability of potential reef materials;
- a study of the biological, chemical or physical component(s) of the artificial reef 'system'.

In reefs constructed for such purposes, the design is often influenced by experimental requirements, such as the need for replication of structures to promote sound data analysis.

Fig. 1.4.10. – *Scientific divers working on a reef designed for scientific research (*Source: *Antony Jensen, NOC).*

1.4.5 Multi-purpose structures

Artificial reefs – especially those that are purpose-built – can be quite costly to establish. In order to maximise the benefits from a given financial investment, reefs are therefore often designed to be multipurpose. For example, reefs designed as deterrents to trawling can also include elements which will increase the biomass of the biota in the area, either by enhancing production or attracting fauna.

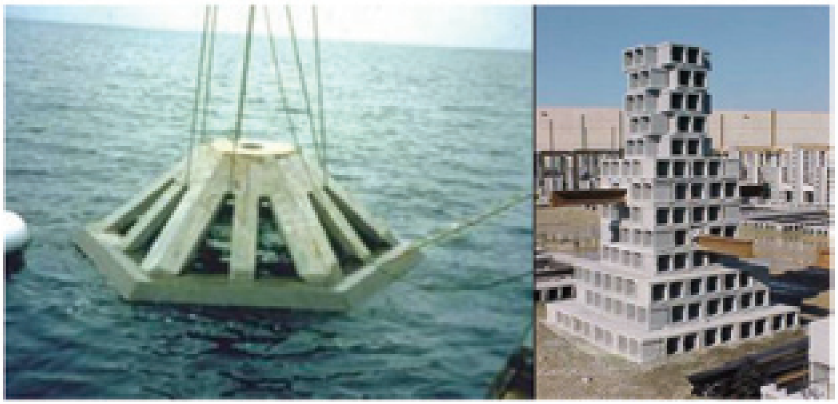

Fig 1.4.11. – *Multi-purpose concrete reef modules. The photograph on the right shows a protection unit with deterrent arms as well as cavities etc for enhancement of biomass.* (Source: *left: Ken Collins, NOC; right: J. Goutayer, Spain).*

1.5 Potential Impacts

Artificial reefs are clearly planned because of their anticipated benefits – both environmental and socio-economic. Potential environmental benefits include:

- improvement of the biological characteristics of the reef on site/surrounding seabed and the infaunal communities;
- the diversion or redistribution of existing tourist burdens – diving and angling – away from sensitive natural ecosystems;
- the diversion of subsistence or commercial angling pressure away from sensitive natural ecosystems;
- protection of vulnerable ecosystems from destructive/illegal fishing techniques;
- reduction of some of the impacts of, for example, caged fish aquaculture, by absorption of excess organic matter and thereby improvement of water quality;
- compensation for habitat loss elsewhere;
- re-establishment of biological communities after, for example, a hurricane or pollution incident.

Potential socio-economic benefits include:

- increased marine/fisheries resources availability leading to improved food security and standard of living for local people;
- enhancement and/or protection of artisanal/coastal fisheries;
- improved fishing conditions for artisanal fishermen (security of the harvest, locations closer to the coast, etc.);
- improvements in beach quality leading to an increase in tourist numbers;
- improvements in recreational opportunities – such as angling and diving - leading to an increase in tourists;
- concentration or attraction of target species for angling;
- enhancement of stocks through habitat creation;
- development of anchoring/mooring sites to promote recreational and commercial boating;
- new or enhanced opportunities for aquaculture developments;
- enhanced supply of fisheries resources; and
- research and educational opportunities.

In some cases, there may be benefits other than that which provided the original motivation for the project. For example, the presence of a reef may help to protect an archaeological site from damage by trawling or dredging.

The majority of these benefits have been mentioned in section 1.4 on the purposes and types of artificial reefs.

However, artificial reefs may also have negative impacts, during their construction, transport to the site, placement and once the reef has been established. These potential negative impacts, the options for mitigation, and possible ways of removal, should be taken into account in making decisions to go ahead with the construction of reefs, and in their design, planning and execution. For example, the use of hooks, eyes or loops in module design could facilitate their removal should it become necessary. This section highlights some of the potential negative impacts of artificial reefs during their construction – and once they are in place - and possible mitigation measures.

1.5.1 Construction and Installation Phase

Atmospheric effects

In general terms, the atmospheric impacts of artificial reefs are minor, and are limited to activities during the construction phase. However, as is true for most other structures used in marine works, the manufacture of reef materials – especially cement – can result in the release of noteworthy amounts of CO_2, and this should be taken into account.

Impacts on coastal habitats

Potential impacts include:

- Impacts related to the extraction or quarrying of reef materials;
- Physical disruption during deployment directly from the coastline.

Mitigation: This can be mitigated by using existing roads and harbour infrastructure.

Sub-tidal impacts

The most likely impacts during construction and installation, apart from the physical disruption in the immediate vicinity of the selected site, are an increase in underwater noise and vibrations during deployment – caused both by explosives and work vessels and equipment - and water pollution.

Although the **underwater noise and vibrations** from vessels and equipment are generally short-term, and likely to be within the 'normal' disturbance created by maritime activities, they may well give rise to at least temporary displacement of mobile fauna (for example, fish, diving birds and marine mammals). Depending on the circumstances, these may have an appreciable effect. Moreover, if **explosives** are used, they may kill fish and other fauna in the area unless more sophisticated technologies are utilised.

Mitigation: Where explosives are used, a single, large explosion should be substituted by a series of smaller explosions, and/or the deployment of the reef can be delayed until after the nesting or breeding season. In addition, nature conservation officials or other appropriate observers can be deployed to ensure that there are no marine mammals within range and/or mammals and birds can be scared away with, for example, a pinger.

Water pollution can occur as a result of the release of pollutants from sediment which are disturbed during deployment of the reef. Fine sediments such as silt and mud, in particular, act as a 'sink' for pollutants such as heavy metals. The levels of pollution in the sediments should be determined as part of the environmental impact evaluation, and sediment disturbance should be minimised by planning and the use of appropriate methods during the deployment.

During reef installation, the presence of the work ships and other mechanical equipment, as well as any dredging which may be required, can cause deterioration of local habitats. Amongst other things, there may be a short term decrease in water transparency, caused by sediment disturbance. This increased **turbidity** can reduce photosynthesis of algae, sea-grasses and corals, and although it is unlikely to have major impacts, if limited to a short period, the issue should be investigated during the environmental evaluation.

Sediments disturbed during construction can also eventually settle out in a new location where they may **smother** existing communities. The extent of the problem will depend on the volume of sediment which is disturbed, and again, should be investigated during the environmental impact evaluation.

Mitigation: As far as possible, the establishment of artificial reefs in areas where the sediments are heavily contaminated should be avoided.

Effects on sites of archaeological or cultural importance

In principle, artificial reefs should not be developed where they are likely to cause long-term damage to archaeological sites, and potential reef sites should be evaluated with this in mind. Damage to archaeological sites is therefore most likely during the construction phase, and appropriate mitigatory actions should be adopted to reduce this possibility.

1.5.2 Ongoing Impacts of the Reef

Impacts on coastal habitats

The most likely impacts on the coastal environment are changes in **sediment movements**, generally as a result of changes in wave action or current velocities and direction – themselves a consequence of poor design. Thus, the long-shore drift of sediment may be reduced to such a level that the coast 'downstream' of the reef is 'starved' of sediment and is eroded. At the same time, an increased volume of sediment may be deposited upstream of the reef.

Where reefs are used to promote tourism and leisure activities, care should be taken to ensure that appropriate infrastructure is available (roads, parking, toilets etc) to ensure that those drawn to the reef are not damaging the coastal environment in their enthusiasm to benefit from the reef development.

Sub-tidal impacts

Deployment of a reef will inevitably **smother** the benthic epifauna and infaunal communities directly under the footprint of the reef. Whether or not this is significant will depend on whether the habitat lost is unique and/or threatened, the presence or otherwise of rare, threatened or endangered species, the size of the reef etc. The possibility of cumulative impacts should also be taken into account.

Another concern is the potential for artificial reefs to provide an opportunity for the establishment and spread of **invasive species**, both by providing suitable, unoccupied substrate, and by functioning as a corridor for alien species to cross unsuitable habitats.

Possible long term environmental changes include:

- changes in the character of the surrounding sediment and infaunal communities;
- changes in the biological communities of the area in which the reef is placed (especially epibiota and fish), including the introduction and establishment of alien species;
- increased exposure to contaminants as a result of physical and chemical weathering of reef structures; and
- localised sediment scour close to reef modules.

Impacts on other beneficial uses

Depending on their location, size, design and materials, artificial reefs may have detrimental impacts on other uses of coastal waters and the associated resources. Activities which may be impacted include:

- navigation;
- harvesting of resources displaced or otherwise negatively impacted by the reef;
- coastal infrastructure and associated activities can be impacted by coastal erosion caused by alterations to longshore transport of sediments;
- recreational activities.

1.5.3 Impacts as a consequence of displacement

Artificial reefs should be sufficiently stable to resist wave and tidal current forces, and, in the case of protection reefs, displacement by trawlers. In either case, the movement, turning over or even breakage of the reef structure, can have the following potential effects:

- Where the artificial reef (or elements thereof) is displaced into adjacent areas of high conservation/ productive value, it may cause damage to the ecosystems, e.g. seagrass or corals;
- After displacement the artificial reef (or elements thereof) may interfere with other uses in the area - for example, navigation, when its position on nautical charts is no longer correct and it therefore becomes a risk to navigating vessels;
- The reef may no longer fulfil its functions, either because it has moved to a different area or because it is broken or its configuration is modified;
- Fragments of the reef may contribute to the broader marine debris problem.

Mitigation: as far as possible, reef structures should be anchored to the substrate to avoid displacement.

2. *The Regulatory Framework*

As indicated above, the growing use of artificial reefs for coastal management purposes, combined with their potential for negative impacts – especially when previously used structures or materials are used - suggests that there is a need for such developments to be properly controlled or regulated. While some countries already have regulations covering artificial reefs in place, the majority do not. Nor is there an explicit regulatory framework at the international level for artificial reefs. This chapter therefore reviews existing regulations and guidelines with a view to providing guidance of a framework at a national level to control or regulate artificial reefs.

2.1 Summary of Relevant International and Regional Instruments

While the United Nations Convention on Law of the Sea (UNCLOS) provides an overall framework for the regulation of activities in the marine environment, there is currently no international instrument which deals specifically with the regulation of artificial reefs. Nevertheless, the London Convention and London Protocol are pertinent as discussed below. Parties should consider, as appropriate, the application of the Basel Convention to this issue as well as the application of the Guidelines developed under regional instruments, such as the OSPAR Convention, the Barcelona Convention and others.

2.1.1 The London Convention and London Protocol

The Convention on the Prevention of Marine Pollution by Dumping of Waste and Other Matter, 1972 (commonly called the "London Convention") was one of the first international conventions for the protection of the marine environment from human activities and has been in force since 1975. The London Protocol was adopted in 1996 to modernise the Convention, and will eventually replace it. The London Convention currently has 85 Parties and the London Protocol has 36 as at October 2008. For further information see http://www.londonconvention.org

The primary objective of the Convention is to prevent the pollution of the marine environment by the dumping of waste and other matter. The primary objective of the Protocol is to protect and preserve the marine environment from all sources of pollution. Under the Protocol, all dumping is prohibited, with the exception of certain listed categories of waste that may be considered for dumping provided that they meet certain criteria, and even then, under strict conditions.

Article III (1)(b)(ii) of the Convention (and similar text is found in the Protocol at Article 1 (4) (2)(3)) expressly state that "*Placement of matter for a purpose other than the mere disposal thereof*" is not included within the definition of "dumping", although this statement is qualified by the words: "..*provided that such placement is not contrary to the aims of this Convention*". Despite this qualification, there has been some concern that the placement or construction of artificial reefs and other such structures, could be used to circumvent the provisions of the Convention by utilising waste materials for construction purposes. The 22nd and 23rd Consultative Meetings (2000 and 2001) therefore developed the following elements of policy guidance concerning the placement of matter for a propose other than the mere disposal thereof:

1. placement should not be used as an excuse for disposal at sea of waste materials;
2. placement should not be contrary to the aims of the Convention;

3. information on placement activities by Contracting Parties should be provided to the Secretariat, as available;[5] and
4. materials used for placement activities should be assessed in accordance with the relevant Specific Guidelines.

The 24th Consultative Meeting (2002) agreed to continue to use the above policy guidance. The Specific Guidelines mentioned in element 4 are the guidelines developed for each of the eight categories of waste which may be considered for dumping under the London Protocol. The categories include dredged material; sewage sludge; fish waste; vessels and platforms; inert, inorganic geological material; organic material of natural origin; bulky items (only where other options are not available); and carbon dioxide streams from carbon dioxide capture processes for sequestration. Of these, the only categories commonly used in the creation of artificial reefs are vessels and platforms, and inert inorganic geological material. The Specific Guidelines for Assessment of Vessels and Inert Inorganic Geological Materials are therefore attached as Annexes 5 and 6 to these guidelines.

Contracting Parties to the London Convention and/or the London Protocol that are considering proposals to deploy an artificial reef constructed using waste material, or consisting of previously used structures or materials, should assess the proposal taking into account the above policy guidance and impose appropriate conditions.

2.1.2 Other International Instruments

Basel Convention

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal[6] was adopted in 1989, and came into force in 1992. The Convention currently has 170 Parties and aims to protect human health and the environment against the adverse effects resulting from the generation, management, transboundary movement and disposal of hazardous and other wastes.

The Convention obliges its Parties to ensure that hazardous and other wastes are managed and disposed of in an environmentally sound manner. To this end, Parties are expected to minimise the quantities that are moved across borders, to treat and dispose of wastes as close as possible to their place of generation and to prevent and minimise the generation of wastes at source. Strong controls have to be applied form the moment of generation of a hazardous waste to its storage, transport, treatment, reuse, recycling, recovery and final disposal.

Within the framework of this Convention, the Parties adopted the *"Technical guidelines for the environmentally sound management of the full and partial dismantling of ships"* in 2002. These guidelines provide information and recommendations on procedures, processes and practices that should be implemented to attain Environmentally Sound Management at ship dismantling facilities. They also provide advice on monitoring and verification on environmental performance. The guidelines furthermore cover vessels requiring only partial dismantling, for example, vessels requiring decontamination with a view to use as an artificial reef.

OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention)[7] is the current instrument guiding international cooperation on the protection of the marine environment of the North-East Atlantic. It combined and updated the 1972 Oslo Convention on dumping of waste at sea and the 1974 Paris Convention on land-based sources of marine pollution and was

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[5]This was later qualified with an agreement that "...voluntary reporting by Contracting Parties on "placement" activities should focus on instances where waste materials were used." (LC 26/15, paragraph 6.12).

[6]For further information see http://www.basel.int.

[7]For further information see http://www.ospar.org/.

signed in Paris in 1992. The Convention came into force in 1998 and currently has 16 Contracting Parties including the European Community.

Under the provisions of the OSPAR Convention, Contracting Parties are obliged, *inter alia,* to take all possible steps to prevent and eliminate pollution; to take the necessary measures to protect the maritime area against the adverse effects of human activities so as to safeguard human health and to conserve marine ecosystems; and, when practicable, to restore marine areas which have been adversely affected.

Of particular relevance here, Article 5 of Annex 2 to the Convention states that: "*No placement of matter in the maritime area for a purpose other than that for which it was originally designed or constructed shall take place without authorisation or regulation by the competent authority of the relevant Contracting Party. Such authorisation or regulation shall be in accordance with the relevant applicable criteria, guidelines and procedures adopted by the Commission in accordance with Article 6 of this Annex. This provision shall not be taken to permit the dumping of wastes or other matter otherwise prohibited under this Annex.*"

The Contracting Parties subsequently developed and approved the "*OSPAR Guidelines on Artificial Reefs in relation to Living Marine Resources*". These guidelines can be accessed on the OSPAR website.[8]

Barcelona Convention

The Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention),[9] was signed in 1976 and amended in 1995, and currently has 22 Contracting Parties. Initially the focus of the Convention was the control of marine pollution in the Mediterranean, but it has been broadened to include more general issues such as integrated coastal zone management and sustainable development.

The Convention has seven Protocols (five in force), including "The Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea" adopted in 1976 and amended in 1995 (Dumping Protocol). This Dumping Protocol effectively makes the provisions of the London Convention and the London Protocol applicable to the Mediterranean Region. In accordance with the London Convention, Article 3 (b) of the Dumping Protocol also excludes "Placement" from the definition of dumping by stating: "*Dumping does not include:....Placement of matter for a purpose other than the mere disposal thereof, provided that such placement is not contrary to the aims of this Protocol*".

Article 6.2 of the Dumping Protocol provides, amongst other things, that the Contracting Parties draw up guidelines for the placement of matter, and in 2005 "*Guidelines for the Placement at Sea of Matter for Purpose Other than the Mere Disposal Thereof"* were duly adopted. Their purpose is to assist Contracting Parties in:

1. considering the consequences for the marine environment of the placement of artificial reefs on the seabed;
2. the fulfilment of their obligations relating to the issue of permits for the placement of matter; and
3. the transmission to the Organization of reliable data on the input of matter covered by the Dumping Protocol.

As in the case of the *OSPAR Guidelines on Artificial Reefs in relation to Living Marine Resources*, this document can be interpreted as a guide that can be used as the basis for Contracting Parties to develop their own specific regulations.

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[8]See http://www.ospar.org/documents/dbase/decrecs/agreements/99-13e.doc.

[9]For further information refer http://www.unepmap.org/.

2.2 Examples of National and Local Regulations for Artificial Reefs

A number of countries have already developed national or local regulations and/or guidelines on artificial reefs. Some of these are summarised in the Table 2.1, which also contains information on where copies can be obtained.

As is evident from the Table, the regulation of artificial reefs is achieved in a variety of ways: for example, through regulations or guidelines for dumping, fisheries, coastal management or the installation of structures in the marine environment in general. In some cases, there are measures specific to artificial reef construction. Moreover, in a number of countries, artificial reef proponents have to obtain multiple permits/approvals (for example, Australia, Japan, UK and the USA).

To a large extent, the approach taken in each country reflects i) the history of the development of regulation of artificial reefs in that country, ii) the type of artificial reefs which predominate (for example, fishery enhancement reefs); and iii) the general importance of artificial reefs in terms of government policy. Thus, where there is a strong emphasis on artificial reef development, a dedicated act and/or set of regulations has been developed. On the other hand, countries where artificial reefs are not common, and the main concern is the possibility that they be used as a means of disposing of waste, tend to regulate artificial reefs under the dumping legislation.

2.3 National/Local Policy, Legislation and Decision-making for the Construction/ Placement of Artificial Reefs

The construction or placement of artificial reefs is still a relatively minor activity in many countries, and, in such cases, can probably be adequately regulated on the basis of existing ocean dumping legislation. However, where the activity is sufficiently common to warrant a more specific and rigorous approach such as a regulatory framework, it should ideally include:

- A formally adopted policy;
- Legislation to provide a basis for implementation of that policy;
- An institutional structure with the mandate and mechanisms to enable it to operationalise the policy and supporting legislation; and
- Strategies and Action Plans or Operational Arrangements to facilitate the implementation of the policy and legislation.

2.3.1 Policy and Legislation

The development of a regulatory framework should, theoretically, be initiated by a political decision recognising the need for government to take action to deal with a particular problem. The next step would be to undertake an analysis of all relevant technical information, policies, legislation and institutional responsibilities – including international obligations – with a view to establishing a policy and, if necessary, embarking on a programme of legal and institutional reform.

Where the policy confirms government recognition of the need for regulation, it would also **designate a competent authority**. The competent authority or sponsoring Government Department as appropriate should then take steps to introduce or amend legislation so as to establish a **legal requirement for authorisation** prior to the construction or placement of an artificial reef.

In the case of artificial reefs, the introduction of appropriate controls, including legislation or regulations, could be a relatively simple process in that most countries now already have some form of Coastal Zone Management legislation in place, and such legislation could easily be amended to include the construction or placement of artificial reefs in the list of regulated activities i.e. activities requiring a permit. Other alternatives would be to expand the legislation regulating the dumping of waste at sea (i.e. national implementation of the London Convention and the 1996 Protocol) to cover artificial reefs, or to develop new, specific legislation. The former would be appropriate in countries where artificial reef development is

Table 2.1: – *Examples of national and local regulations covering artificial reefs*

COUNTRY	COMPETENT AUTHORITY	LEGISLATION/ REGULATIONS/ GUIDELINES	WEB REFERENCE
Australia	Department of Environment and Heritage	Environment Protection & Biodiversity Conservation Act 1999; Environment Protection (Sea Dumping) Act 1981; Sea Installations Act 1987.	www.environment.gov.au/coasts/pollution/dumping/installation.html
	Great Barrier Reef Marine Park Authority	Guidelines for the Management of Artificial Reefs in the Great Barrier Reef Marine Park	http://www.gbrmpa.gov.au/corp_site/management/eim/guidelines_artificial_reefs
Canada	Environment Canada	Canadian Environmental Protection Act Clean-Up Guideline for Ocean Disposal of Vessels	http://www.pyr.ec.gc.ca/ep/ocean-disposal/english/cleanupguideline_jul01_e.htm
Japan	Ministry of Agriculture, Forestry & Fisheries/ Fisheries Agency	Fishing Ports and Fishing Grounds Improvement Law, 1950. Basic Policy on the Improvement of Fishing Ports and Fishing Grounds, 2007 Regulations for the Evaluation of Artificial Reef Project, 1999. Standards for Planning for the Improvement of Artificial Reefs, 2000. Guidelines to Design Fishing Ports and Fishing Grounds, 2003. Guidelines for the Artificial Reefs with Obsolete Ship and Vessels, 1982.	www.maff.go.jp (Japanese)
Republic of Korea	Ministry of Maritime Affairs and Fisheries	National regulation on construction and management of artificial reefs (January, 1998/July, 2004)	

Spain	Ministry of the Environment and Rural and Marine Affairs	The Shores Act, 1988 Maritime Fisheries Act, 2001 Royal Decree 798/95 (criteria and requirements for AR projects for fisheries purposes) Methodological Guidelines for Artificial Reefs Placement, 2008	www.mma.es http://www.mapa.es/es/pesca/pags/arrecifes/arrecifes.htm
UK	Marine and Fisheries Agency	Food and Environment Protection Act, 1985 (as Amended); Coast Protection Act, 1949 (as Amended); and Marine Works (Environmental Impact Assessment) Regulations, 2007	www.mceu.gov.uk
USA	- US Environmental Protection Agency; - U.S. Army Corps of Engineers; - National Oceanic and Atmospheric Administration	Toxic Substance Control Act Clean Water Act Rivers and Harbors Act Liberty Ship Act National Fishing Enhancement Act National Marine Sanctuaries Act **Note**: There are also various acts and plans at state level.	
		National Artificial Reef Plan	http://www.nmfs.noaa.gov/sfa/PartnershipsCommunications/NARPwCover3.pdf
		Policy Statement of the National Marine Sanctuary Progra-mme: Artificial Reef Permitting Guidelines	http://sanctuaries.noaa.gov/library/national/arpolicy_071205.pdf
		National Guidance: Best Management Practices for Preparing Vessels Intended to Create Artificial Reefs, 2006	http://www.epa.gov/owow/oceans/habitat/artificialreefs/guidance.html
		Guidelines for Marine Artificial Reef Materials (1997/2004)	http://www.gsmfc.org/publica-tions/GSMFC Number 121.pdf

limited to, for example, the placement of obsolete ships, while the latter would probably only be justified in countries where there is an active artificial reef development programme.

Whichever approach is selected, any regulations or controls should also establish the operational arrangements, including the **permitting or similar authorisation process, technical criteria** against which decisions should be made, and an appropriate **compliance monitoring and enforcement** system. Further guidance on the permitting process, compliance monitoring, and enforcement are provided below, while technical considerations are covered in chapter 3.

2.3.2 The permitting process

Where a permit process is to be developed a number of decisions regarding aspects of the system will need to be made. A possible permit process is described in the following sections.

For purpose-built artificial reefs, the most important part of the reef planning process is the design – which includes selecting appropriate materials and designing the detailed structure, based both on the purpose of the reef, and the oceanographic conditions at the proposed site. Thus, before a detailed proposal can be submitted, a number of studies need to be undertaken – for example:

- Coastal dynamics – waves, currents, sediment transport etc – which will affect things such as the stability of the reef;
- Behaviour and population dynamics of the target species (for fishery enhancement reefs) – which will determine the optimum depth, size and complexity of the reef.
- Carrying capacity of the marine area. The number of units included in the project and their distribution on the seabed and the possible accumulative or synergistic effects with other structures previously placed in the area should be considered.

Similar studies will need to be undertaken prior to the placement of reefs made of previously used materials or structures, such as vessels. The development of a detailed proposal for an artificial reef therefore requires a fairly substantial investment. It is therefore recommended that a two-stage permitting process be introduced. Where compatible with the country's regulatory regime, this can take the form of two formal steps in the application process as outlined below. Alternatively, the preliminary application can be replaced by an informal consultation between the proponents of the reef and the regulatory authorities.

1 Preliminary application

Proponents should be required to submit an initial application comprising a motivation for the project (covering social, technical, ecological, economic and administrative issues and specifying clear primary and secondary objectives of the reef) as well as a relatively brief outline of the concept of the reef covering the purpose of the reef, its design, materials, general location etc. Provided that the proposal is in line with the country's policy, and is compatible with international obligations (such as those under the London Convention/Protocol), approval is then given for the applicant to move on to the next step and submit the full application.

The intention of this step is to avoid a situation where an artificial reef developer spends a considerable amount of funds on developing the proposal, and undertaking an environmental impact evaluation, only to find that the proposal was flawed from the outset. This preliminary application may, therefore, include a number of options. During the preliminary consultations with the competent authorities the most feasible one/s (if any) will then be selected for further development. These consultations will also serve to identify what studies will be required to provide the basis for designing the reef. Approval to move on to the next step then effectively amounts to an "approval-in-principle" i.e. the proponent can reasonably expect that the full application will be approved provided that it addresses any issues identified during the required studies, and unless the environmental impact evaluation reveals major problems which cannot be addressed through appropriate mitigatory actions.

Further guidance on the studies which may be required is provided in Annex 4.

2 Full application

The minimum information to be submitted with the application should include:

- the motivation from the preliminary application;
- complete and detailed plans of the reef showing:
    1. its specific location on the seabed (coordinates, distance from the coast, depth and type of seabed);
    2. the design and materials and, where appropriate, the number of modules to be used;
    3. where previously used structures or materials are to be used, the process of preparation, clean-up and/or decontamination;
- copies of the studies undertaken and which provide the justification for the design, materials, location etc selected for the project;
- a description of the work site for the construction phase, the infrastructure available and how the structure will ultimately be transported and placed in the intended site;
- relation to other nearby installations and beneficial activities which could be affected, and indicating how concerns raised in the environmental impact evaluation are intended to be addressed;
- a description of the placement methodology, resources required for this purpose, and the associated risks;
- technical specifications and proposals for a system of quality control to ensure that these specifications are met;
- the outcomes of the environmental impact evaluation, cost-benefit analysis and consultation process (copies of the full reports to be attached); and
- an estimate of the anticipated costs of the project.

A model application form is attached as Annex 1.

Once an application has been received, it should be assessed against established criteria. Guidance on such criteria and the decision-making process is provided in chapter 3 of these guidelines.

3 Provision for trials and scientific research

The permitting process should make provision for trials using small-scale reefs so that the predictions with regards the likelihood of the reef achieving its objectives can be tested prior to full-scale deployment.

2.3.3 Environmental Impact Evaluation, Cost-benefit Analysis & Public Consultation

The majority of countries already have legislation in place requiring **environmental impact evaluation** for a variety of activities which can relatively easily be amended to include artificial reef projects. These guidelines therefore do not provide detailed recommendations on the environmental impact evaluation process itself. However, guidance on the environmental studies required, as well as the process of identification and assessment of potential impacts from a technical perspective, is provided in Annex 4.

The environmental impact evaluation should be based on the specific options (in terms of design, materials and location) which will be submitted in the full application (and which may differ from the preliminary application as a result of the studies undertaken during the detailed design process), and should include an assessment of these studies themselves – in particular, those on environmental factors such as waves and currents, which will influence the likelihood of success of the project. The environmental impact evaluation should also cover potential impacts during both construction and deployment phases.

The environmental impact evaluation should include a **cost-benefit analysis,** and an artificial reef should only be established if, after due consideration of socio-economic and environmental effects, a net benefit can be demonstrated in relation to the defined objectives. Such analysis should consider both short and long-term costs and benefits, and the length of time that the reef is expected to be functional. If it is anticipated that the reef might begin to disintegrate at some point, the costs of removing the debris should be factored in.

Public consultation and review should be an integral component of the assessment process, with well-publicised opportunities for involvement of those stakeholders likely to be directly affected by the development. Where appropriate, such consultation should include neighbouring countries.

The final report of the environmental impact evaluation should include **recommendations** as regards issuing a permit or not, and, if so, on permit conditions, including mitigation measures, monitoring programmes etc.

2.3.4 Compliance monitoring and enforcement system

When approval is given for the construction or placement of an artificial reef, provision must also be made for a mechanism to ensure that this is done in accordance with the stipulated conditions. This mechanism is generally known as **compliance monitoring** and should cover both construction and implementation phases.

During construction, the competent authority/ies should undertake inspections of the construction site and the developing structure to ensure it meets the specifications outlined in the permit. Where necessary, this can include hiring an independent technical expert to assist with the process.

A representative of the competent authority should also be on site during deployment of the reef.

Once the reef is in place, compliance can be assessed on the basis of reports on the efficacy and environmental monitoring programmes which should be provided to the competent authority on a regular basis. Further information on efficacy and environmental monitoring is provided in Annex 7.

2.3.5 Permit and Permit Conditions

A permit for the construction and/or placement of an artificial reef should only be issued once the proposal has been assessed against the established criteria, and has been found to be acceptable. Moreover, permit conditions should aim to minimise environmental disturbance, and maximise benefits. In this process, due consideration should be given to the 'precautionary approach' and best environmental practice.

Guidance on criteria and the decision-making process is provided in chapter 3 of these guidelines.

A permit for an approved artificial reef project should contain, as a minimum, the following information and conditions:

- Permits should clearly state the purposes for which a reef is being constructed, as well as the approved design, materials, location and construction methods;
- Permits should specify who will be responsible for carrying out any management measures, including mitigation, monitoring programmes and reports; and, where necessary, dismantling;
- The permit should also require the permitee to ensure that the position, surveyed depth and dimensions of the artificial reef are indicated on nautical charts. In addition, there should be advance notice of the placement to mariners and hydrographic surveying services;
- Monitoring programmes : All artificial reef projects should include monitoring programmes with the following objectives:
  - to ensure that the reef is constructed and operated according to the conditions specified in the permit i.e. compliance monitoring;
  - to assess to what extent the reef is meeting the stated purpose for which it was constructed. i.e. were the design, materials, location etc. suitable for the intended function. This is generally termed efficacy monitoring; and
  - verification of the positive and negative **environmental impacts** of the reef;

- Dismantling: should the monitoring studies indicate that the reef is not achieving its objectives, or that it is having serious, unanticipated negative effects, it might be necessary to dismantle and remove the structure/s. Again, the permit should make this clear. Guidance on dismantling is given in Annex 8; and
- The permit should identify the "owner" of the reef, indicate the owner's liability for future damage caused by the reef, and outline the procedures for claims.

A model permit is provided in Annex 2, while further information on efficacy and environmental monitoring is provided in Annex 7.

3. *Technical criteria for the assessment of artificial reef projects*

In view of the fact that artificial reefs can be costly to construct, and can have negative impacts, their development and deployment needs to be properly planned so as to ensure that choices, especially with regards to design, materials, location etc, are such that, in addition to fulfilling the purpose for which they are intended, they also meet environmental requirements. This section therefore outlines the criteria which should be taken into account during the process of making decisions on the approval or otherwise of artificial reef projects. As far as possible, the criteria should be built into the Terms of Reference for the Environmental Impact Assessment which should be conducted by an agency or consultant unrelated to the reef proponents.

3.1 General criteria

There are a number of broad criteria against which all artificial reef proposals should be assessed. These include both legal and technical criteria as outlined below, while more specific criteria are discussed in sections 3.2 and 3.3. More detailed information on certain aspects can be found in Annex 3.

3.1.1 Legal criteria

The purpose of the proposed reef should be credible and compatible with government policy, national legislation and the international obligations of the country. Thus, for example, the competent authority of any Contracting Party to the London Convention or Protocol (and preferably of all countries) receiving an application to construct and place an artificial reef comprising waste materials or previously used materials or structures – including obsolete vessels – should ensure that the use of the materials is consistent with the provisions of the London Convention and Protocol, as appropriate, and that such materials are assessed and prepared according to the relevant guidelines of the Convention and Protocol.

3.1.2 Technical criteria

i) Feasibility

The design of the proposed reef should be based on materials that are easy to acquire or manufacture, and the handling, transport, and deployment of the modules and other elements should be safe and cost effective. In order to meet this criterion, designs should be relatively simple.

ii) Functionality

The reef should be able to fulfil the purpose or objectives for which it is being constructed. Thus, for example, in the case of a production reef, the design and materials should provide habitat suitable for attracting the intended target species. Or, in the case of a reef being constructed for diving, the location should be such that it is accessible, and provides a safe diving environment.

iii) Environmental Compatibility

Artificial reefs should only be established if, after due consideration of all socio-economic and environmental costs (e.g. water quality impacts or habitat alteration), a net environmental benefit can be demonstrated, in relation to the defined objectives. Materials with documented environmental risks should be avoided, and reefs should not have major impacts on other beneficial uses in adjacent areas.

Care should also be taken not to develop too many reefs in any particular area, exceeding the local carrying capacity.

iv) Durability and stability

It generally takes some years for artificial reefs to be colonised by biological communities to the extent that they are able to achieve their objectives. For this to happen, they should be durable and stable in the face of an often very hostile marine environment. Thus materials should be durable, and, together with the design, stable enough to maintain the structure and function of the reef, even under the worst weather conditions likely at that site. Reefs constructed of tyres, for example, have frequently failed under such conditions, and are, therefore, not widely favoured.

Another aspect to be taken into account is the geology of the seabed where the reef is to be constructed. Heavy concrete reef modules, for example, have sunk without trace in muddy sediments off the west coast of Taiwan, China. As a general rule, it is recommended that the weight of the reef is at least double that of the specific gravity of seawater, or, alternatively, that the structure is actually anchored to the seabed.

If reefs used for protection against illegal trawling are not sufficiently stable, they can be dragged by the trawl nets, creating additional negative impacts. They should therefore be specifically designed to be able to withstand the power of vessels trawling in the area, including the specification of adequate anchoring points.

Stability not only affects the chances of a reef meeting its objectives, but, as discussed in section 1.5, a reef which is displaced, can have additional negative impacts.

v) Suitability of proposed monitoring programmes

The installation of an artificial reef should be preceded by baseline studies aimed at providing benchmark data for the subsequent monitoring of the effects of the reef on the marine environment. Following deployment of the reef, there should be short, medium and long-term monitoring programmes in order to verify whether the management objectives are fulfilled (compliance monitoring) and whether the anticipated benefits materialise.

The monitoring programme should also be aimed at establishing and assessing the environmental impacts and/or conflicts of the artificial reef with other legitimate uses of the maritime area or parts thereof. Depending on the outcome of such monitoring, it may be necessary to carry out alterations to the structure or to consider its removal. In the case of placements taking extended periods of time (years), monitoring should be concurrent with the construction in order to influence modification of the reef, as required.

Monitoring proposals submitted with applications should be assessed on the basis of the above and, providing they are suitable, should become part of the permit conditions. More detailed information on indicators and other aspects of monitoring programmes can be found in Annex 7.

vi) Suitability of proposed dismantling arrangements

If and when monitoring studies indicate that a reef is not meeting its objectives, or that there are negative effects which were not identified in the planning phase, it might be necessary to dismantle and remove the anchored structures. The dismantling process will be more or less complex, depending on the bathymetric characteristics of the sea bed, the depth at which the structures are located and the type of reef.

The application should therefore include at least preliminary proposals of possible ways of dismantling which, if suitable, will also become part of the permit conditions. More detailed information of dismantling arrangements can be found in Annex 8.

A minimum requirement would be that the proponent accepts liability for the costs of dismantling.

3.2 Specific criteria

The most important part of the artificial reef planning process is the design – including the selection of materials and the exact location and structure. These will ensure both that the reef attains its objectives and that they are appropriate from a technical, economic and environmental perspective. Given the range of purposes for which artificial reefs are constructed, there are a variety of options with regards the design, materials and location. Nevertheless, there are a number of criteria which can be applied across all reefs. This section provides a summary of these, while more specific criteria based on the actual purpose of a particular reef can be found in section 3.3. Additional details are also available in Annex 3.

3.2.1 Design

The design and materials should:

- Depending on their purpose, comprise dimensions and shapes that can "attract" animal life, promoting the quick attraction and settlement of algae, fish, molluscs, corals, etc. on the surface and surroundings;
- Be of sufficient engineering strength, both as individual units and as an overall structure to withstand the physical stresses of the marine environment and not break up, potentially causing serious interference problems over a wide area of seabed;
- Be able to achieve the objectives with minimum occupation of space and interference with the marine ecosystems; and
- Be such that the reef could be removed, if required.

3.2.2 Materials

Artificial reefs can be built from natural, recycled, or prefabricated materials. In combination they can support a higher variety of biological communities and therefore be attractive to a wider range of users. The main aim in selecting the materials should be to ensure that the reef can fulfil its purpose while also complying with safety and environmental criteria. In general:

- Artificial reefs should preferably be built from natural materials;
- The materials used should be inert, and should be resistant to deterioration in seawater. For the purpose of these guidelines, inert materials are those which do not cause pollution through leaching, physical or chemical weathering and/or biological activity;
- Materials which are compatible with the provisions of the London Convention and Protocol may be utilised. Their acceptability or otherwise should be determined on the basis of a careful assessment of their physical and chemical characteristics according to the relevant guidelines of the London Convention and Protocol. Some types of dredged material, such as rocks, boulders etc, may be considered as construction material for artificial reefs provided that they meet the above criteria;
- The materials utilised may affect the nature of the species which will colonise the reef, and their selection will therefore also be influenced by biological factors such as the type of feeding of the target species; and
- Reefs in exposed, high energy area should be built of heavy materials such as rocks, concrete and steel.

Further information on the advantages and disadvantages of various materials can be found in Annex 3.

3.2.3 Location

The placement of any artificial reef should only be undertaken once there is a thorough understanding of the local environment, including waves and currents, sediment transport, the seabed, water and sediment quality, biological communities, and other beneficial uses. Such environmental information will assist in determining whether the reef is likely to meet its objectives since the local conditions i) will potentially affect the stability of the reef; and ii) should provide a suitable environment for the target species. The information also provides a baseline against which to measure potential impacts caused by the reef on the environment and/or other beneficial. In general:

- Artificial reefs should also be constructed and installed in such a way as to ensure that the structures are not displaced or overturned by force of towed gears, waves, currents or erosion processes for their objectives to be fulfilled at all times;
- Artificial reefs should not be constructed in areas prone to hurricanes or other major storm events;
- The placement of artificial reefs should be done with due regard to any legitimate activity underway or foreseen in the area of interest, such as navigation, tourism, recreation, fishing, aquaculture, nature conservation or coastal zone management; and
- Prior to placement of an artificial reef, all groups and individuals who may be affected or interested, should be informed on the characteristics of the artificial reef as well as on its location and depth of placement. They should be given the opportunity to make their views known in due time prior to its placement.

The following aspects need to be taken into account in assessing the location of a proposed artificial reef:

- distance to the nearest coastline;
- coastal processes including sediment movement;
- water depths (maximum, minimum, mean);
- influence on stratification;
- tidal period;
- direction and velocity of residual currents;
- wind and wave characteristics;
- impact on coastal protection;
- influence of the structure on local suspended solid concentrations;
- recreational areas and coastal amenities;
- spawning and nursery areas;
- known migration routes of fish or marine mammals;
- sport and commercial fishing areas;
- areas of natural beauty or significance cultural, historical, or archaeological importance;
- areas of scientific or biological importance;
- shipping lanes or anchorages;
- designated marine disposal sites;
- seabed pipelines;
- military exclusion zones, including ordnance dumpsites; and
- engineering uses of the seafloor (e.g. potential or ongoing seabed mining, undersea cables, desalination or energy conversion sites).

While in many cases the aim should be to avoid conflict with the above interests, the management objectives for an artificial reef could be directed specifically at interference, such as discouraging the use of certain types of fishing gear.

3.3 Function-specific criteria

For purposes of this section, reefs are divided into three categories: i) those whose primary function is to enhance biodiversity or productivity (for fisheries or ecological purposes); ii) reefs which are constructed to protect biological resources; and iii) reefs intended to promote recreation and tourism.

3.3.1 Reefs for enhancement of productivity and/or biodiversity

i) Purpose, design and materials

The structure of the reef - **shape, size and configuration** of the modules - is key to determining the biomass and diversity of the species which it will attract. Many different studies have shown that particular species have a marked preference for particular types of design. Thus the characteristics of the blocks or modules (their dimensions, size, weight, spatial heterogeneity, basic group of units, arrangement and distance between blocks) are design factors that should be considered in each case, based on the preferences of the target species. However, a number of general points can be made as follows:

- there is a direct relationship between the complexity of a reef and the diversity of the species it will attract;
- the shape and dimensions of the reef affect not only the biomass, but also the total number of species and individuals;
- depending on its size and dimensions, an artificial reef can be visually attractive and act as a spatial reference for determined species;
- the profile of a reef also has an effect on the species and biomass. Thus, for demersal species, the profile of the reef should be low. However, when the purpose is to create a habitat with many different species, a combination of high and low reefs is required;
- the diversity and biomass of communities on an artificial reef are also influenced by the distribution and number of modules. A reef divided into different modules (rather than massed together) can attract a greater quantity of species and individuals, in addition to providing different areas for simultaneous uses, such as SCUBA diving and fishing;
- the quantity and nature of interstitial spaces will also determine the nature and diversity of organisms settling on the reef, and should be designed with the target species in mind. However, it should be born in mind that reef fish prefer openings proportionate to their size, so that small openings should be included to ensure the survival of young fish;
- in general, fish prefer cavities with many openings to enable them to escape from predators. This can also be catered for by providing smaller cavities for young fish and smaller species. They also prefer cavities where there is light;
- the size, number and orientation of cavities should also take into account the courtship and breeding behaviour of the target species, as well as whether they are territorial or gregarious (with smaller cavities in higher numbers for territorial species and the contrary for gregarious species);
- stagnant water can detract from productivity. The overall design and layout of reef structures – and associated cavities - play an important role in ensuring adequate water circulation; and
- the total surface area available is more important than its overall size in determining the reef biomass. Thus, the higher the surface available for the settlement of algae and invertebrates, the greater the source of food for other levels of the reef community and, therefore, the greater the productive capacity. However, the design of the artificial reef should be aimed at attaining its objectives, while at the same time occupying the smallest area of the seabed possible, and with minimum interference with the natural marine ecosystems.

The main considerations in terms of materials, are their roughness and chemical composition. For example, very flat, smooth surfaces will hinder the settlement of organisms on the reef, since they prefer to colonise rough surfaces or areas with openings and cavities similar to those of natural rocks.

Artificial reefs specifically for the purpose of fishery enhancement (for commercial or sport fishing) should enhance population growth/rate of survival of the targeted species by:

- providing additional structures and habitats during appropriate growth stages;
- improving the availability of food by increasing biomass in the area; or
- increasing the availability of shelter from natural predators.

ii) Location

A reef built in an area where there are already existing stocks of the target species, and which matches the preferred habitat, will clearly have a greater chance of success.

iii) Socio-economic considerations

The proposal should indicate, on the basis of an analysis of the current fishing activities, how the reef will contribute to enhancing the sustainable management of the relevant resources.

3.3.2 Reefs for ecosystem/resource protection

Applications to place reefs intended for the protection of ecosystems (e.g. seagrass, biogenic reefs) from illegal trawling/dredging activities should demonstrate:

- proof of existing illegal fishing activities being carried out in the area;
- evidence of damage caused to the ecosystems;
- failure of other fishing management alternatives to control these illegal activities; and
- adequate design.

Protection reefs should be specifically designed to be able to withstand the power of vessels trawling in the area and to either hook nets or tear them up. Therefore, they tend to be built of dense, relatively plain modules, such as concrete blocks with deterrent arms.

3.3.3 Reefs for leisure or recreational purposes

i) Socio-economic considerations

In the case of artificial reefs to be used for leisure or recreational purposes, their justification also should be based on:

- The number of potential users directly involved: indicators could be the number of sports licenses issued in the province and surrounding areas or the number of companies that support the activity (direct sales, renting, surf clubs, SCUBA diving clubs, etc.);
- The number of people indirectly involved, mainly the workers in the associated service sector (hotels, bars and restaurants, maintenance, etc.);
- Potential for existing recreational SCUBA diving activities to be improved in the area; and
- The economic value of the associated activities.

ii) Purpose, design and materials

Diving reefs may be utilised by two categories of divers: i) those interested primarily in the diving experience itself; and ii) those with an interest in the biology of the reef. Those in the first category, in particular, generally show a strong preference for diving on wrecks – hence the fairly common practice of using obsolete vessels for the creation of artificial reefs, where the attraction of particular species is not an important factor. Where the intention is to create a biologically interesting reef, the design process should be approached in the same manner as for the establishment of a reef for biological purposes (section 3.3.1).

iii) Location

In both cases, however, safety of prospective divers should be a prime consideration. Thus, while they should be easily accessible, they should also not be in sites shallow enough to become dangerous under low tide conditions or storm events.

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Annex 1

Model Application Form[10]

Name and contact details of competent/responsible Authority:

Eg. for England and Wales within the UK – Marine and Fisheries Agency

Details of legislation under which the application is made:

Examples:

i) For UK - Food and Environment Protection Act, 1985 (as Amended), and Coast Protection Act, 1949 (as Amended)

ii) For Spain - Maritime Fisheries Act, 2001 and The Shores Act, 1988

iii) For Australia - Environment Protection & Biodiversity Conservation Act 1999; Environment Protection (Sea Dumping) Act 1981; and Sea Installations Act 1987.

Guidance to applicants:

To cover, for example:

- Description of process (preliminary application, full application etc);
- Number of copies required;
- Supporting documentation required (depending on whether it is a preliminary or full application);
- Minimum time period required for processing of application;
- Fees payable in respect of the application; and
- An indication of other consents or authorizations required (eg. disposal of dredged material, approval from Port or Maritime Safety Authority – depending on proximity to ports and/or navigation routes).

List of authorizations or consents being applied for:

In most countries, artificial reefs are regulated together with other coastal management structures, and a number of different Acts may apply. The application form should therefore allow as far as possible for the consents required under the different Acts to be processed in parallel.

In addition, should the construction, for example, require dredging, it may be necessary to apply for a separate permit to dispose of the dredged material.

Details of applicant (and/or agent): including, as appropriate, name, contact details, company registration etc.

Status of the application: preliminary or full application.

[10]An example of the application form used in the UK can be found at: http://www.mfa.gov.uk/environment/index.htm.

Anticipated duration of the construction phase:
Full description and anticipated cost of the project: including • Objectives • Design and materials (including size and quantity) • Location (coordinates and a map of appropriate scale indicating activities in adjacent areas, as well as eg. marine protected areas, cultural/ archaeological sites) • Method of construction/placement • Costs
Supporting documents required for Full Application: • Environmental Evaluation Report • Report on public consultations • Proposed mitigation measures • Construction plans • Schematic drawing of appropriate scale • Proposed monitoring plan • Arrangements for dismantling should this be required • Copies of other consents or authorizations obtained.

Declaration and signature of applicant
Section for official records/ signatures etc.

Annex 2

Model Permit[11]

Name of Act/s under which the permit is issued:
Statement of authorization (subject to conditions in the attached schedule):
Permit number:
Period of validity: start date to expiry date.
Name and details of Permitee : including company registration as appropriate.
Signature and title of representative of Competent/Responsible Authority:
Date:

SCHEDULE TO PERMIT NO. xxxx

Details of the project as approved: (generally as provided in the application form, but including any amendments agreed during the approval process) • Objectives • Design and materials (including size and quantity) • Location (coordinates, water depth etc) • Method of construction/placement and construction plans • Schematic drawing • Mitigation measures • Monitoring plan (including baseline survey prior to deployment if required) • Arrangements for dismantling • Ownership and liability
Names and details of agents and/or contractors to be engaged by the Permitee, and conditions attached thereto: for example, agents/contractors to be provided with copies of the permit; requirement for consultation with competent/responsible authority should new/additional contractors be engaged.
Inspection of operations: officials of the Permitting Authority (and other relevant agencies) to have access to permits and site as required.

[11]An example of an actual licence issued by authorities in the UK can be found at: http://www.mfa.gov.uk/environment/documents/scylla-licence.pdf.

Contact details of Permitting Authority:
Reporting requirements:
Supplementary Conditions: For example, where an shipwreck or obsolete vessel is involved, the requirements for cleaning of the vessel prior to placement, and associated certifications; final inspection prior to placement; notification of any modifications; navigation warnings during placement; removal of debris generated by the deployment; animal/bird protection measures; operation of vessels and equipment during construction/placement; annual fees; variation fees; criteria for cancellation of permit.
Annexures: eg. in the case of vessels, a copy of the relevant Guidelines of the London Convention (see Annex 5 of these Guidelines); Monitoring Plan.

ACKNOWLEDGEMENT BY PERMIT HOLDER

Acknowledgement of receipt:
Signature and date:

Annex 3

Overview of materials and designs for artificial reefs

Artificial reefs are nowadays used for a variety of purposes in coastal environments, and have evolved over the past few hundred years from what were essentially piles of rubble, to highly sophisticated structures with specific designs depending on their purpose. For these purpose-built reefs, the design process includes the selection of materials and the design of the structure, taking into account the purpose of the reef, target species where appropriate, and the specific environmental conditions at the proposed location – as well as economic considerations, availability of materials etc. This is intended to ensure both that the reef attains its objectives and that they are appropriate from a technical, economic and environmental perspective.

Given the range of purposes for which artificial reefs are constructed, there are a variety of options with regards materials and designs, and the purpose of this Annex is to provide an introduction to these.

1 Materials

Artificial reefs can be built from natural, recycled, or prefabricated materials. In combination they can support a higher variety of biological communities and therefore be attractive to a wider range of users. The main aim in selecting the materials should be to ensure that the reef can fulfil its purpose while also complying with safety and environmental criteria. In general:

– Artificial reefs should preferably be built from inert materials.

– The material used should be inert and should be resistant to deterioration in seawater. For the purpose of these guidelines, inert materials are those which do not cause pollution through leaching, physical or chemical weathering and/or biological activity;

– Materials, including the previously used structures, which are compatible with the provisions of the London Convention and Protocol may be utilised. Their acceptability or otherwise should be determined on the basis of a careful assessment of their physical and chemical characteristics according to the relevant guidelines of the Convention and Protocol. Some types of dredged material, such as rocks, boulders, etc may be considered as construction material for artificial reefs provided that they meet the above criteria.

– The materials utilised may affect the nature of the species which will colonise the reef, and their selection will therefore also be influenced by biological factors such as the type of feeding of the target species;

– Reefs in exposed, high energy area should be built of heavy materials such as rocks, concrete and steel.

1.1 General criteria

Function

The selection of the appropriate materials is vital to ensure that an artificial reef meets its objectives. Particularly, in reefs designed to act on the biota, which will have a considerable influence by the roughness and chemical composition of materials. For example, very flat surfaces will hinder the settlement of organisms on the reef, since they prefer to colonise rough surfaces or areas with openings and cavities similar to those of natural rocks. The existence of attached organism is not so important in the deep region reefs.

Environmental compatibility and durability

The materials used for the construction of an artificial reef should minimise risks to the environment and possible conflicts between users. In addition, they should be compatible with the uses for which it is designed.

To maintain the functionality of an artificial reef it is vital to ensure that the materials are long lasting, chemical stabile in sea water or they may deteriorate quickly. If the aim is to use materials that are not commonly employed in maritime works or installations, their level of resistance and deterioration should be analysed prior to their placement. The materials of artificial reefs should not have a high rate of chemical decomposition in the marine environment, with the potential to release toxic products that alter the biological quality of the ecosystem and the physical-chemical quality of the water and sediments. In addition, they should be resistant to the effects of time and potential impacts from anchoring and fishing activities.

Stability

The materials used to design an artificial reef should be sufficiently stable to the impact of waves and tidal currents, so that they are not tipped over, rolled or fractured. Otherwise, this could represent a danger to the surrounding ecosystems and other sea users (fishing, navigation, beaches, etc.).

Structures near the surface that could suffer from the effects of waves should have an open structure and undergo hydrodynamic tests before their placement.

1.2 Material types

As indicated above, artificial reefs can be built from natural, recycled, or prefabricated materials. Prefabricated reefs have the advantage that they can be built with the desired characteristics. They can be built with a variety of different materials, although concrete is commonly used, since it is a material that is not easily degraded, it can be shaped, is stable, and its texture is similar to that of natural reefs. Other options include ceramic materials, and a matrix of PVC and concrete.

Prefabricated reefs can also be made of materials which include waste. For example, coal ash or ash from incinerators can be combined with cement to create reef modules. However, where such materials are being considered, they should be assessed using the generic or "Revised Specific Guidelines for Assessment of Inert, Inorganic Geological Material" developed by the London Convention as appropriate (see Annex 6).

One of the advantages of recycled materials is their higher availability. Many different "second hand" materials have already been used for this type of project, including vessels and vehicles, as well as oil platforms, construction rubble, concrete waste products, tyres and cement stabilised ash and sludge. The creation of an artificial reef with this type of material is sometimes regarded as a method of reusing them for productive purposes, rather than just taking them to dump sites. However, many studies have revealed that some "second hand" materials are not suitable for this purpose - for example, wood, glass fibre, plastic, tyres, light vehicle bodies, glass fibre boats and mouldings and light metal domestic appliances, (e.g. fridges and washing machines), often cause problems. Many are also prohibited from dumping under the London Convention. They are therefore generally not recommended for artificial reef construction.

The previously used structures which are most commonly used for artificial reef construction are vessels and platforms. In such cases, the vessel or platform must be cleaned prior to placement. The London Convention and London Protocol Specific Guidelines for Assessment of Vessels and Specific Guidelines for Assessment of Platforms and Other Man-Made Structures at Sea may serve as a useful starting point for this process. However, additional measures for preparation, clean up and decontamination may also be considered for vessels and platforms placed as artificial reefs to account for the sensitivities of the near-shore habitats (see Annex 5).

Natural rocks can be used successfully when the aim is to provide a rocky substrate on the seabed for the settlement of determined species. However, some rocks may contain high levels of heavy metals that could be liberated into the sea by leaching, and they should be assessed according to the London Convention Specific Waste Assessment Guidelines as shown in Annex 6. In addition, they might not be available locally, thus involving further environmental impacts arising from transport.

As far as costs are concerned, although prefabricated reefs have quite high construction costs, these are likely to be offset by the costs of preparation and/or adaptation of recycled materials – such as the very elaborate clean-up required for vessels and platforms. Moreover, given the potential pollution risks, it is likely that more extensive monitoring of the reef would be required.

The monitoring of various artificial reefs over past years has yielded a considerable amount of information on the advantages and drawbacks of a range of different materials used in artificial reef construction. This is summarised below.

Concrete

- Advantages
  - Concrete materials are compatible with the marine environment.
  - Concrete is highly durable, stable and readily available.
  - Concrete can be readily formed into any shape for the development of prefabricated units.
  - Concrete modules can provide adequate surfaces and habitats for the settlement and growth of organisms, which in turn provide a substrate, food and places of refuge for other invertebrates and fish.
- Disadvantages
  - A major drawback in the use of concrete in the manufacturing of reefs is its weight, which necessitates the use of heavy equipment to manipulate it. This increases the terrestrial and maritime transport costs.
  - The deployment of large concrete blocks or prefabricated units requires the use of heavy sea equipment, which is not only costly but dangerous.
  - The weight of the concrete increases the possibility of it sinking into the marine sediments.
  - High carbon footprint associated with the manufacture of cement and the need for aggregates.

Wood

- Advantages
  - This material is readily available in any area.
  - Wood infested by, for example, shipworms (bivalve molluscs that perforate wood) contains a network of tunnels, increasing the complexity of the reef, and providing places of refuge.
  - The complex structure provided by a deteriorating wooden reefs is also a source of food, and can attract large concentrations of fish. Artificial reefs located in deeper and colder waters have been shown to harbour many different organisms.
  - Coconut palm root stumps (used in Kerala, India) are heavy (do not float) and provide a complex habitat ideal for juvenile fish.
- Disadvantages
  - Wood generally has a short life in marine environments, and is quickly broken down by micro-organisms and perforating organisms. The deterioration of the reef's structure can cause some sections to break and float into areas beyond the reef, causing interference with other legitimate sea uses (navigation, use of beaches by bathers, etc.).
  - Wood is a very light material and must be anchored to ensure stability.

- – The processed wood commonly used in construction is often treated to avoid rotting. It may thus be contaminated by compounds which are toxic to marine organisms.

Rock

- Advantages
  - – Quartz is composed of silicon dioxide, (limestone - calcium carbonate), one of the main components of many natural reefs and fully compatible with the environment.
  - – Quarry rock is a very dense, stable and durable material, with a low probability of moving out of the reef's location.
  - – Quarry rocks attract fish and provide a good surface for benthic organisms.
  - – A range of sizes of rock can accommodate different species and life stages.
- Disadvantages
  - – The costs of transport and placement of the artificial reef are high and require the use of heavy equipment.
  - – Some rocks may contain high levels of heavy metals that could be liberated into the sea by leaching.

Electrodeposition

This technology uses electrolysis to deposit a calcium-based material onto an artificial surface thereby producing a framework consisting mainly of calcium-carbonate and similar to reef limestone. It is still very much in the experimental phase and there is limited evidence that it is viable. It also carries very high initial costs.

The advantages and disadvantages claimed by the developers (Biorock) are as follows:

- Advantages
  - – It has minimal environmental impacts.
  - – Installation does not require heavy lifting machinery.
  - – Its versatility allows the creation of submarine structures of any size and form.
  - – The structures knit quickly to the natural reef and become integrated.
  - – The electric field may attract marine fauna and promote the growth of corals and seaweeds.
  - – It is possible to create substantial coral reefs in relatively short periods of time (1 year).
- Disadvantages
  - – The cost may be very high in some locations
  - – The requirement of electrical provision may discount certain locations.
  - – This technique is also undeveloped and unstable.

Obsolete ships and vessels

- Advantages
  - – There is a long history of accidental wrecks on the seabed so their value as reefs and their potential impacts are relatively easy to determine.
  - – Vessels provide interesting areas for recreational or technical SCUBA divers. They are also usually used as places for sports fishing, and can have a very positive impact on the economy of the area.
  - – The usage of abandoned boats with large steel hulls as artificial reefs can be cheaper than taking them to be dismantled.

- Due to their high vertical profile, vessels can attract pelagic and demersal fish species. Vertical surfaces intercept currents, promoting the growth of sessile filter-feeding species
- Vessels can decrease the pressure on other natural and artificial reefs in the area, including the physical damage caused by, for example, boat anchors.
- Their use is regulated by international standards and there is extensive documentation on the use of obsolete vessels as artificial reefs.

• Disadvantages
- The lifespan of vessels as artificial reefs can be affected by the preparatory clean-up and other operations, as well as by the use of explosives to sink them.
- It is difficult to guarantee the stability of the vessel, especially in extreme weather conditions, as various factors are involved, such as the depth, extension of the vessel's surface exposed to the energy of waves, orientation of the vessel, height of the wave, friction forces, weight of the vessel, vertical profile and currents generated by the storm.
- Where the vessel is damaged by storms, the loss of integrity of the structure can increase the risks to SCUBA divers (disorientation or physical damage caused by sharp edges).
- Vessels may contain a range of contaminating agents, including PCB's, radioactive materials, hydrocarbons, and heavy metals, which are hard and costly to eliminate. The costs will increase with the size of the boat, number of compartments and spaces, and overall complexity of the structure.
- In general, boats offer a proportionally lower surface area and/or opportunity for shelter for demersal and invertebrate species than other materials with similar volumes.
- The use of vessels as artificial reefs can cause conflicts between fishermen and SCUBA divers.
- The corroding surface of the steel hull may lead to periodic loss of colonising organisms.
- In comparison with smaller artificial reef modules, once a vessel is sunk it is difficult and costly to move if it has not been placed correctly, or to remove should the need arise.
- The high vertical profile of vessels makes them more prone to movement and/or structural deterioration due to the currents and waves generated under extreme weather conditions.
- Vessels, especially those that are highly deteriorated, have a high risk of sinking accidentally while they are being towed (either for cleaning or anchoring purposes).
- Vessels have a high value as alternative steel recycling sources.
- The use of explosives to sink vessels (especially when requiring large quantities) can cause structural damage, project waste, atmospheric problems and can pose a risk to marine life. (The excessive use of explosives is often more a case of a publicity stunt than necessity. Opening one valve below the waterline could sink a ship).

Obsolete marine platforms

• Advantages
- Residual structures of marine platforms can be used to increase the colonisation in areas with a low diversity of marine organisms, since they can bring attractive fish species and other species of economic importance.
- Given the quantity of flora and fauna attracted, they are also used as places for sub-aquatic tourism and sports fishing.
- The creation of artificial reefs with these structures creates alternatives for SCUBA divers that can reduce the pressure on other coastal points, with the corresponding positive effects on the economy of the area.

- The steel components on platforms are stable on the seabed, and are long-lasting, thus ensuring their stability in the case of extreme weather conditions.
- The use of these structures anchored to the sea bed (mostly metallic) as artificial reefs can be cheaper than their dismantling and removal.
- Depending on the activity carried out in the platform, the materials can be cleaner and less problematic than those on vessels as regards the safety and handling, in addition to complying with the same recreational objectives at a lower cost.
- Due to their high vertical profile, platforms are capable of attracting pelagic and demersal fish species. The vertical surfaces intercept currents, promoting the growth of sessile filter-feeding species.

- Disadvantages
  - Relocation is not allowed in some areas, but encouraged in others e.g. Louisiana, USA
  - Platforms could contain contaminating substances, such as hydrocarbons, and heavy metals. The cost of clean-up is proportionate to the size and complexity of the structure.
  - The 1982 United Nations Convention on the Law of the Sea (in force as from 1994), as well as the IMO Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the EEZ, adopted in 1989 by resolution A.672(16), repeated the obligation of dismantling such offshore installations.
  - In the scope of Barcelona Convention, the Protocol for the Protection of the Mediterranean Sea against Pollution Caused by the Exploration and Exploitation of the Continental Shelf, and the Seabed and its Subsoil was adopted in 1994, agreeing the following: "Each State will request the operator to dismantle all abandoned installations".
  - The OSPAR Decision 98/3 establishes "The dumping, and the leaving wholly or partly in place, of disused offshore installations within the maritime area is prohibited"
  - The use of explosives to sink structures such as offshore platforms causes atmospheric contamination problems which can lead to a high risk of nearby marine life.

2 Design

Purpose-built reefs are generally either to enhance the biological productivity of the area in which the reef is situated, or to protect marine resources or habitats.

2.1 Production reefs

When the reef is intended to promote productivity– for conservation or fisheries purposes - the design and materials should:

- comprise dimensions and shapes that can "attract" plant and animal life, promoting the quick attraction and settlement of algae, fish, molluscs, corals, etc. on the surface and surroundings;
- be of sufficient engineering strength to withstand the physical stresses of the marine environment and not break up, potentially causing serious interference problems over a wide area of seabed;
- enable the reef to achieve the objectives with minimum occupation of space and interference with the marine ecosystems;
- be such that the reef could be removed, if it becomes necessary.

Production reefs include the greatest variety of materials and structural designs, the most common being the so-called cell or alveolar modules. Their main characteristic is the presence of cells or small cavities or niches (alveoles) destined to host different species. These are often made from concrete but

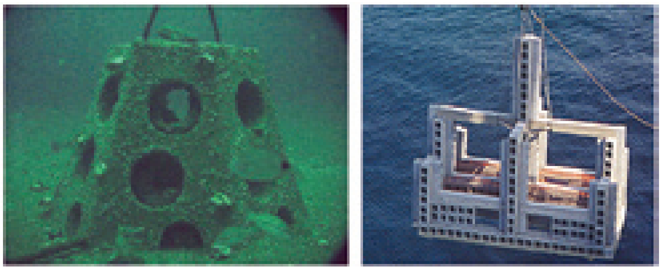

Fig. 2.1 – *Concrete structures with cell openings*
*(*Source: *left: Robert Martore, South Carolina Department of Natural Resources; right: J. Goutayer, Spain).*

can be a heap of randomly arranged blocks or rocks (good to provide shelters for crabs and lobsters) or a steel lattice (favoured for fish attraction).

The number and size of cavities, as well as the shape of the modules (height, profile, surface/volume relationship, etc.) has a major impact on the diversity and abundance of the organisms which will be attracted to the reef. In general, the more complex the structure, the higher the diversity of species that will use the reef as settlement substrata, refuge, feeding area, or breeding area. Overall size of the reef is also an important issue, and minimum volumes of material and seabed area covered need to be in the 25,000 m^3 plus and km^2 range respectively, if self sustaining ecosystems are to be created.

Configuration, forms and size of the artificial reef

Many studies have shown that individual species may display a marked preference for particular designs. The characteristics of units (blocks or modules), the dimensions, size, weight, spatial heterogeneity, basic group of units, arrangement and distance between blocks are design factors that should be considered in each case, based on the objectives and target species.

Where the intention is to create an ecosystem with a large diversity of organisms, the structures should be as complex as possible, since there is a direct relationship between the complexity and diversity. Depending on its shape, size and dimensions, an artificial reef can be visually attractive and act as a spatial reference for determined species.

Properly designed artificial reefs used for fishery enhancement purposes can be very efficient in increasing the survival of the species, by improving their growth and breeding rates. This has a direct effect on the biomass and biodiversity of the ecosystem and fishing resources.

The profile of a reef also has an effect on the species and biomass. For a reef whose purpose is to provide habitat for demersal species, the profile should be low. However, when the purpose is to create a habitat for many different species, a combination of high and low reefs will be required.

The diversity and biomass of communities on an artificial reef will depend on the distribution and number of modules. A reef divided into different sections (rather than having all the modules massed together) can attract a greater quantity of species and individuals, in addition to providing different areas for simultaneous uses, such as SCUBA diving and fishing.

Interstitial spaces

The quantity and nature of interstitial spaces will also determine the nature and diversity of organisms settling on the reef.

Cavities should be designed specifically for the target species. In general, fish prefer cavities with many openings to enable them to escape from predators. They also prefer cavities where there is light. In addition, reef fish prefer openings proportionate to their size, so a reef should include openings of a variety of sizes to enable the survival of both adult and young fish.

The reef structure should also have enough openings and cavities to allow water to circulate through them, preventing it from becoming stagnant in some areas and detracting from the total productivity.

Total surface area

The total surface area available is more important than the overall size in determining the reef biomass. The higher the surface available for the settlement of algae and invertebrates, the greater the availability of food for other levels of the reef community and therefore, generally, the greater the capacity to produce biomass.

However, in some cases, total area is not proportional to quantity of settlement. Kelp planted in a particular position, for example, will preclude the settlement of other species in the vicinity. In other words, settlement can be complicated, for example, by competition amongst rooting forms of algae.

As a general rule, the design of the artificial reef should be aimed at the achieving the objectives with the minimum occupation of seabed and interference with marine ecosystems.

2.2 Highly specialised reefs

Highly specialised, prefabricated modules are now available from commercial organisations around the world. One example (of many) is a ceramic reef module that has been specially designed for the colonisation of coral species. It achieves this by providing a shape which is appropriate for coral settlement and a material (food grade ceramic) which avoids some of the pH issues that can arise when using standard concrete mixes in reefs aimed at promoting coral settlement.

2.3 Protection reefs

In contrast to production reefs, protection reefs are not intended to attract or promote settlement of marine species, and therefore tend to be built of dense, relatively plain modules, such as concrete blocks with deterrent arms. They have most commonly been used to prevent illegal fishing activities. The placement of deterrent protection reefs should however, preferably be done in appropriate combination with other techniques to prevent illegal trawling.

The design of anti-trawling reefs will depend on the characteristics (normally engine power) of the fishing vessels that are fishing illegally and the type of sea bed. Hollow or solid structures are generally built with reinforced concrete and their shape (cube, cylinder, mixed, etc.) will mainly depend on economic factors. These structures must be heavy, (8 tonne or so) so that they can not be dragged by the nets of the fishing vessels. These then have a series of deterrent elements, which either hook nets or tear them up. They usually have bars or arms that are horizontally, vertically or diagonally linked to the main structure. The most common deterrent elements are huge steel beams that go through the blocks, although other elements can be used. They are usually placed in a cross-shaped structure to exert pressure in all directions.

Fig. 2.2 – *Eco reef modules being placed on a damaged reef and 2 years after deployment (image © eco reef.com).*

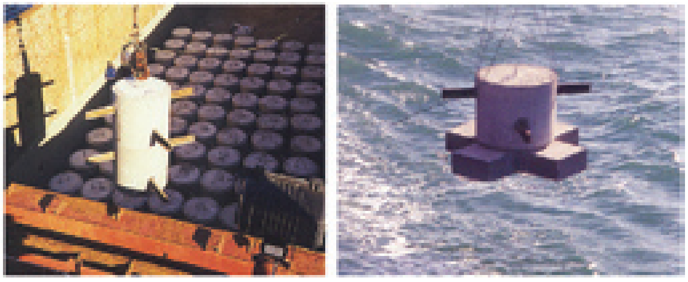

Fig 2.3. – *Concrete structures with deterrent elements (General Secretariat of the Sea, Spain).*

Another important aspect of the design of protection artificial reefs is the spatial distribution of each reef unit. In order to prevent trawling activities in protected areas, artificial reefs must be composed of various deterrent modules or units, distributed so that they cover the area to be protected. The lay-out of units can be polygon-shaped or in rows, etc. provided that the relationship between maximum effectiveness and economic cost/environmental efficiency is maximised.

Annex 4

Environmental studies and impact evaluation for artificial reefs

1 Scope

The purpose of this Annex is to i) describe the studies which are recommended to facilitate the development of an appropriate design for an artificial reef; ii) identify the type of information which should be considered during the evaluation of potential environmental impacts for artificial reef projects; and iii) to describe briefly, the process of that evaluation when determining whether an artificial reef project meets the objectives of an artificial reef (refer to section 1.3 of the Guidelines) and decision makers determine whether the project should go forward.

2 Baseline environmental studies

An important part of the artificial reef planning process is the design, including the selection of materials, dimensions, overall size etc. These will depend on a variety of factors including the objectives of the reef, the target species where appropriate, and the **environmental conditions** at the proposed site/s - both the physical environment and the social context of the location.

An understanding of these environmental conditions is also fundamental to an evaluation of the potential impacts of a proposed artificial reef. This section therefore describes the more general studies which are important to artificial reef projects, while later sections deal with issues more specific to the design and impact evaluation processes respectively.

In addition, it should be necessary to judge the contents of the environmental studies and impact evaluation for artificial reefs according to the purpose, the feature, etc. of each project. Moreover, it is desirable to carry out the objectives by taking the depth of the contents into consideration in these enforcements.

2.1 Oceanographic conditions at the proposed location

It is important to have an adequate understanding of the waves and currents at the proposed location of the reef in order that i) the artificial reef can be designed to withstand the forces generated by waves and currents without being displaced or overturned; and ii) possible changes in the hydrodynamics of the area – and related processes such as sediment transport – can be predicted.

2.2 Sediment dynamics, characteristics and quality

The movement of sediments in near-shore coastal areas is subject to the influence of waves and currents, and includes long-shore transport as well as onshore/offshore movements. It may be seasonal in nature, varying with the weather patterns. Knowledge of the sediment dynamics is important in selecting a site for an artificial reef so as to ensure i) that the reef will not end up being covered or buried by the sediment after a certain period of time; and ii) that the reef will not interfere with the natural sediment transport patterns as this may modify areas of erosion and deposition in adjacent locations.

Sediments – particularly fine-grain sediments with high levels of organic material – can act as sinks for contaminants such as heavy metals and PCBs. These can be re-released into the water column if the sediments are disturbed – for example, during the placement of an artificial reef. In addition, the type and depth of sediments can affect the ability of the seabed to support an artificial reef. It is therefore important to have a clear picture of the physical and chemical make-up of the sediments in the proposed location, including levels of any contaminants to determine whether it is a suitable site for a reef.

2.3 Geomorphology

The nature of the seabed at the proposed location of an artificial reef is important in determining whether it can actually support the weight of the reef – and therefore ensure its stability. Reef modules have, for example, been known to sink into muddy sediments. The geomorphology is also important in determining the nature of the biological communities (soft or hard-substrate species), as changes to the seabed caused by the placement of a reef can have implications for these communities.

2.4 Water quality status

The characteristics of the seawater around the proposed site of an artificial reef are crucial to determining the likelihood of the reef being able to meet its objectives, particularly when these include biological aims. Baseline studies should assess variables such as temperature, salinity, turbidity, and concentrations of suspended matter, and dissolved oxygen and inorganic nutrients. Studies should also include potential contaminants where there is a possible source nearby. For example, indicators of faecal contamination should be measured if the proposed site for a diving reef is in the vicinity of a municipal outfall or large stormwater discharge, as this may have health implications for both human and marine visitors to the reef.

It is also important to know whether the reef materials could contribute to contamination under the water quality conditions prevailing at the proposed site.

2.5 Biological communities

Artificial reefs are intended to support or protect biological communities. It is therefore important to have an understanding of the existing biology and ecology of the proposed site. Studies should establish *inter alia* whether threatened, sensitive or unique species or habitats are present in the area; the suite of existing communities and their habitat requirements; and the feeding and other requirements of any target species. Where protection reefs are planned, the boundaries of the community/ies to be protected must be carefully determined.

Having a clear understanding of potentially affected biological communities prior to reef deployment also makes it easier to evaluate impacts post-deployment.

2.6 Geography of the area

Any reef that is constructed is likely to have some kind of impact on the surrounding area, including the landward component of the adjacent coastal zone. Recreational or educational reefs, for example, will increase the demand for shoreside facilities to support the increased number of divers. The presence of a reef may also alter the visual appearance of the area, both the landscape and that underwater, and may alter the original values of the area.

2.7 Socio-economic status

The introduction of an artificial reef into an area can have negative impacts on the living marine resources and the existing and potential socio-economic activities based on the exploitation of those resources. For example, a recreational reef could increase the volume of boating in the area and with it, oil spillages. On the other hand, it could increase revenue from commercial activities related to tourism. It is therefore important to have a clear understanding of the economic value – and sustainability - of such activities in comparison to those expected to derive from the presence of the reef.

Studies of economic benefits should also include an analysis of non-living resources, other nautical sports, marine infrastructure etc.

2.8 Cultural heritage

Artificial reef projects should not impact on any site of historic or archaeological importance. A catalogue of such sites must therefore be obtained or developed prior to any decisions on the location of an artificial reef.

3 Specific studies for the design of the artificial reef

The final design that is selected for an artificial reef at a specific location should be such that the reef is:

- Feasible;
- Functional;
- Compatible with the environment; and
- Durable and stable.

Consideration should also be given to the possibility of removal should that become necessary.

The design of a reef therefore requires a substantial amount of information, and in addition to the studies outlined in section 2 above, some studies specific to the type of reef, and/or to the location, might be required. Some examples of such studies are outlined below:

3.1 Study on the stability of the reef in relation to wave and tide effects

While the background environmental study will provide a description of the waves and currents in the proposed site, this study should evaluate design options in relation to wave and tidal current forces, with a view to preventing displacement or breakage of the reef structure. The study should include modeling of the proposed structures and materials.

3.2 Studies for the design and location of protection reefs

Protection reefs are intended to act as deterrents to trawling and other destructive activities, protecting resources or habitats with a high ecological value. Placement of deterrent protection reefs should be carefully balanced against other techniques to prevent illegal bottom fishing gears. To be effective, both the design and location of the reefs should be carefully selected. In order to ensure the correct positioning of the reefs, the ecosystems to be protected and the activities of the trawling and other bottom gears fleet (trawling areas, length and position of nets, etc.) or other relevant activities should be properly mapped.

As far as the design of anti-trawling reefs is concerned, the shape, size and distribution of the structural elements comprising the reef should be based on factors such as the maximum power of trawling vessels operating in the area; the maximum span of the trawling nets and the maneuverability of the trawling fleets. In order to guarantee their effectiveness, the design should exceed the resistance capacity indicated by the model.

3.3 Biological factors and the design of fishery enhancement reefs

The settlement on or attraction to an artificial reef by a particular species will depend to a large extent on the size, arrangement, shape, location and structure of its elements. To inform the design parameters, it is therefore important to have information on variables such as the behavior, population status of the particular species in the area and the ecological characteristics that determine its habitat. Where the objective is to attract a range of reef species, the design of the reefs should have multiple elements.

Important variables to take into account in designing these reefs are:

- The depth of the natural habitat of the target species;
- The presence of the species, their young or eggs in the area;
- Existing population stock and dynamics;

- The characteristics of areas used for shelter from predators, as well as for courtship and breeding;
- Inter-specific competition;
- Territoriality or gregarious behaviour (smaller and higher numbers of cavities for territorial species and the contrary for species with a gregarious behavior); and
- Feeding preferences.

3.4 Fishing activity and the design of fishery enhancement reefs

Understanding the existing fishing effort in the area will determine the level of exploitation and thus the value of placing a reef in an area. It will also assist in deciding on the number of structures or size of the reef. Prior to the establishment of a fishery enhancement reef it is therefore important to have data on:

- the fleet;
- the location and state of the fishing ground;
- the main fishing techniques used;
- catch statistics; and
- the typical species in the catch.

3.5 Economics of reefs for recreational SCUBA diving, surfing, and water sports

Because one component for the success of these reefs will depend on the social demand, it is important to assess the extent of existing activities in the area and their capacity for expansion. This should be determined on the basis of the following:

- The number of existing and potential users;
- The number of people indirectly involved – primarily through the associated service sector (hotels, bars and restaurants, maintenance, etc.); and
- The economic value of these activities.

4 Artificial Reef Projects Evaluation and Determination

Another important element of both the design and decision-making process for an artificial reef project is to predict the significance of potential impacts of the reef on the environment during its construction, deployment and removal phases based on the baseline information already gathered. If the anticipated impacts are sufficiently serious, the application to place the reef may be turned down. Alternatively, the impacts can be reduced by altering the design or location of the reef, or by employing other corrective and mitigatory measures.

This process involves two elements: i) identifying potential impacts; and ii) evaluating their significance in relation to a specific project.

4.1 Identification of potential impacts

For each phase of an artificial reef – construction, operation and possible dismantling – there are a variety of potential impacts. In order to ensure that all such impacts are considered, the identification process should take place in an objective and structured manner.

The first step is to identify, for each phase, the activities which could generate impacts – see the examples in the table below:

PHASE	Examples of Impact-generating Activities
Construction Phase	Transport of structural elements to sinking site
	Works for sinking of the structural elements
	Presence of the equipment and means used in the installation works
Operating Phase	Biological activity of the artificial reef
	Presence of the sunken structure
	Functionality of the artificial reef
Possible Dismantling or Abandonment Phase[12]	Withdrawal of the structural elements
	Transport of the structural elements to the final disposal site
	Presence of the dismantling works
	Presence of remains of the structural elements

The next step is to identify the nature or type of the potential impacts. These can generally be grouped into 4 categories: Physical-Natural, Perceptual, Socioeconomic and Cultural. Within each category, there may be a number of sub-categories, each of which is associated with one or more variables which can be impacted as a consequence of the placement of an artificial reef (see the table below).

Thus, for example, in relation to impacts on the Physical-Natural System, during its construction phase, a reef may negatively affect air quality at the construction site. On the other hand, the construction activities are likely to have a positive effect on the Socio-economic and Human System in the form of employment opportunities. Similarly, during the process of deployment, the reef may impact on the Perceptual System by increasing noise levels and creating vibrations through the use of explosives.

PHYSICAL-NATURAL SYSTEM	
Subsystem	**Examples of variables which can be impacted**
Atmospheric environment	Air quality
Coastal environment	Coastal morphology (coastal dynamics)
Marine environment	Submarine morphology (bathymetric variations)
	Water Quality
	Sediment quality
	Benthic communities
	Pelagic communities

[12]See Annex 8.

PERCEPTUAL SYSTEM	
Subsystem	**Examples of variables which can be impacted**
Perceptual environment	Coastal, marine and submarine landscape
	Sound levels and vibrations
SOCIOECONOMIC AND HUMAN SYSTEM	
Subsystem	**Examples of variables which can be impacted**
Social environment	Direct and indirect employment
	Recreational and leisure areas
Economic environment	Fishing activity (traditional fishing)
	Tourism
Infrastructural environment and other uses	Infrastructures
	Sinking sites
	Navigation
	Fishing Grounds
CULTURAL SYSTEM	
Subsystem	**Examples of variables which can be impacted**
Historical-cultural environment	Historical heritage

4.2 Evaluating the significance of anticipated impacts

Once the activities which may generate impacts have been identified, and the nature of those impacts described, their significance can be evaluated, on the basis of the information already gathered, according to the following steps:

Basic Description of the Impact: The activities which are capable of generating impacts for each variable should be identified and the potential impacts then described in some detail according to the specifics of the project. For example, air quality could be impacted during the construction phase, and the dismantling phase, but is unlikely during the operating phase. If the modules are cement, then the manufacturing process can result in the release of noteworthy amounts of CO_2.

Detailing the potential impacts in this way also facilitates the identification of mitigatory measures where they are deemed necessary.

Characterisation of the Impact: Each potential impact should then be adequately characterised. As an example, the legislation in force in the European Union establishes the necessity to take into account for the characterisation of the likely significant effects of the proposed project on the environment, the direct effects and any indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative effects of the project.

Significance of the impact: The significance of each individual impact can then be determined on the basis of the descriptors used in the characterisation phase. Thus persistent, cumulative, and irreversible impacts are more significant than temporary, simple, reversible ones. Finally, in general, each impact is then assigned to one of the following categories:

- **Positive Impact:** Impacts which improve the environment – for example, where the reef enhances fisheries or biodiversity, or reduces fishing pressure on sensitive areas.
- **Nil or low significance Impact:** These impacts, even though they can manifest themselves, are, for example, only temporary and easily reversible.
- **Significant Impact:** These impacts are likely to be immediate, cumulative and persistent, although they can be reversible, particularly if corrective measures are taken. They can also be reduced through mitigatory measures, and should be studied and/or monitored in some depth.
- **Critical Impact:** These impacts are persistent, irreversible and continuous and should be studied in detail during the planning phase of the project, with a view to modifying the project so as to avoid such impacts. Should this not be possible, they could lead to the cancellation of the project.

5 Corrective and Mitigatory Measures

Measures which are adopted with the objective of minimising impacts can be grouped into a number of categories depending on when they are applied, as well as the effect they may have on the environmental variable under consideration. These categories include:

- Preventive or mitigatory measures: measures geared towards preventing an impact.
- Corrective measures: measures applied after the onset of an impact, and which are aimed at reducing its effects as much as possible.
- Compensatory measures: measures adopted when it is not possible to mitigate or apply corrective measures to a given impact. Instead, measures are taken in other areas in order to compensate for the damage caused.

Within these categories, the specific measures adopted for any project will depend on the details of that project. However, decisions should be based on the principle: *"prevention is better than cure"*, suggesting that preventive measures are preferred over corrective ones.

While specific measures are project-dependent, some general options are outlined below:

5.1 General preventive measures

- Reefs should not be placed in areas of high environmental and cultural value.
- The timing of the reef installation should be planned so as to limit the impacts on biological communities and socioeconomic activities. For example, placements should not be done during the breeding season of birds and marine mammals, or during peak tourist season.
- The vessels involved in the installation of the reef should avoid travelling through sensitive areas en route to and from the site.
- Machinery used on the project should be properly maintained.
- Areas with high archaeological potential should be surveyed ahead of the placement and a specialist should then be available on site during placement in order to guarantee an immediate response in the event of finding any archaeological or cultural remains.
- Strict compliance with the Preparation and Clean-up Guidelines for Placement at Sea of Vessels for the construction of artificial reefs (see Annex 5).
- Occupational hazards should be addressed through an Occupational Risk Prevention Plan and a Health and Safety Plan.

5.2 Preventive measures for situations of risk or emergency.

Appropriate measures should be put in place to ensure an adequate response to situations of risk or emergency (other than occupational health and safety) that might arise during the course of the project - for example, oil spillage.

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This Annex identifies the types of information useful for decision makers to evaluate proposed artificial reef projects and determine if the project meets the objective of an artificial reef. After assessing baseline environmental studies, project design and evaluation, and appropriate mitigatory measures, decision makers should determine whether the project in question should proceed, if more information is needed before a decision can be reached, or that the project should not proceed. Because of the numerous factors and variables that influence a particular artificial reef project, project evaluations and determinations should be made on a project-by-project basis. Once all the information and studies have been gathered and analyzed, it may be concluded that a proposed artificial reef project might not be a good candidate to execute.

Annex 5

Specific guidelines for assessment of vessels and platforms or other man-made structures at sea.

SPECIFIC GUIDELINES FOR ASSESSMENT OF VESSELS

1 INTRODUCTION

1.1 The Guidelines for the Assessment of Wastes or Other Matter that May be Considered for Dumping,[13] referred to in short as the "Generic Guidelines", as well as the Specific Guidelines for Assessment of Vessels addressed in this document are intended for use by national authorities responsible for regulating dumping of wastes and embody a mechanism to guide national authorities in evaluating applications for dumping of wastes in a manner consistent with the provisions of the London Convention 1972 or the 1996 Protocol thereto. Annex 2 to the 1996 Protocol places emphasis on progressively reducing the need to use the sea for dumping of wastes. Furthermore, it recognizes that avoidance of pollution demands rigorous controls on the emission and dispersion of contaminating substances and the use of scientifically based procedures for selecting appropriate options for waste disposal. When applying these Guidelines uncertainties in relation to assessments of impacts on the marine environment will need to be considered and a precautionary approach applied in addressing these uncertainties. They should be applied with a view that acceptance of dumping under certain circumstances does not remove the obligation to make further attempts to reduce the necessity for dumping.

1.2 The 1996 Protocol to the London Convention 1972 follows an approach under which dumping of wastes or other matter is prohibited except for those materials specifically enumerated in Annex I, and in the context of that Protocol, these Guidelines would apply to the materials listed in that Annex. The London Convention 1972 prohibits the dumping of certain wastes or other matter specified therein and in the context of that Convention these Guidelines meet the requirements of its Annexes for wastes not prohibited for dumping at sea. When applying these Guidelines under the London Convention 1972, they should not be viewed as a tool for the reconsideration of dumping of wastes or other matter in contravention of Annex I to the London Convention 1972.

1.3 The schematic shown in Figure 1 provides a clear indication of the stages in the application of the Guidelines where important decisions should be made and is not designed as a conventional "decision tree". In general, national authorities should use the schematic in an iterative manner ensuring that all steps receive consideration before a decision is made to issue a permit. Figure 1 illustrates the relationship between the operational components of Annex 2 of the 1996 Protocol and contains the following elements:

- .1 Waste Prevention Audit (Chapter 2)
- .2 Vessels: Waste Management Options (Chapter 3)
- .3 Waste Characterization: Chemical/Physical Properties (Chapter 4)
- .4 Disposal at Sea: Best Environmental Practices (Chapter 5) – (Action List)

[13] The Nineteenth Consultative Meeting of Contracting Parties to the London Convention 1972 adopted these Guidelines in 1997.

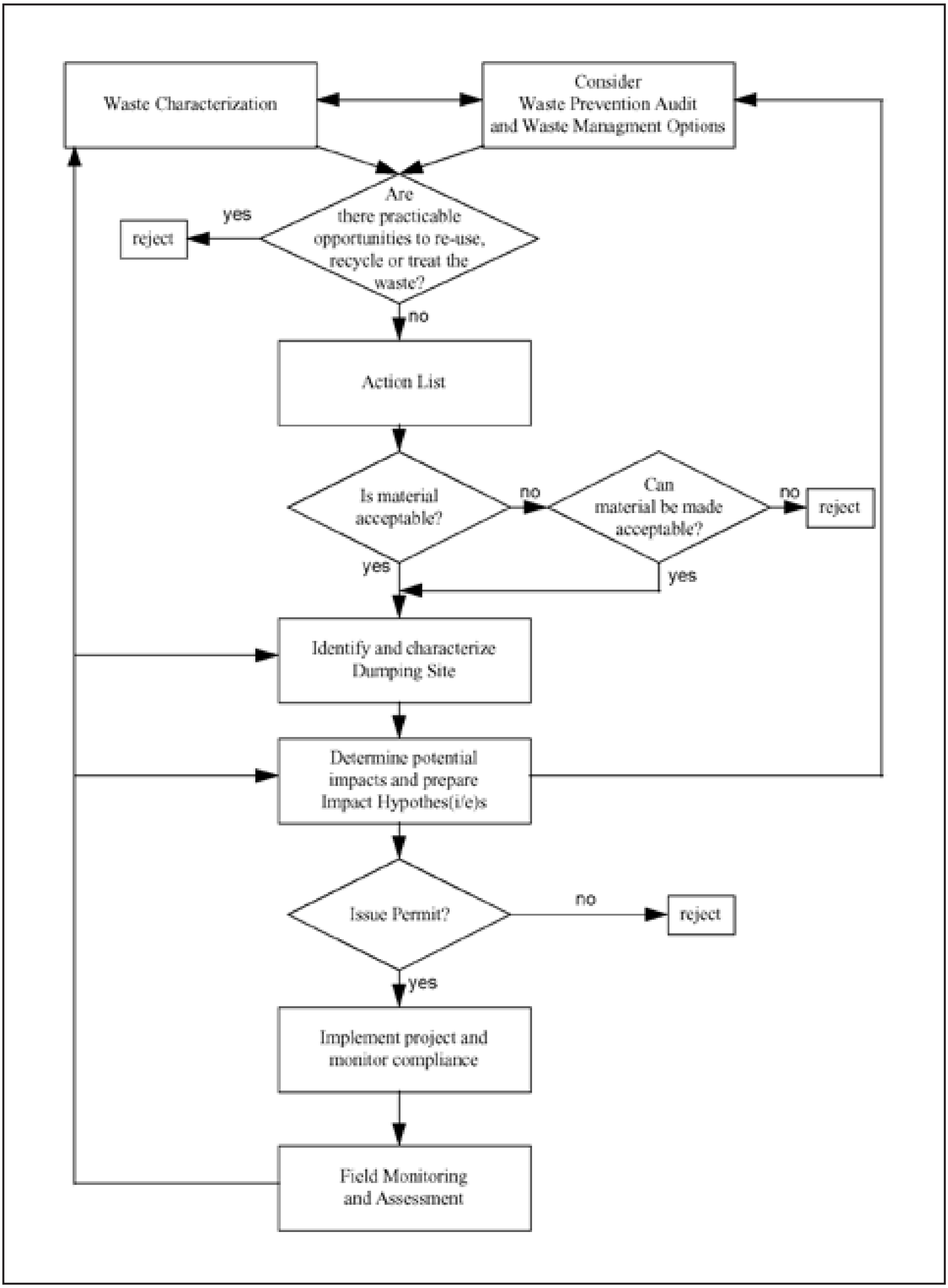
Waste Characterization
Consider
Waste Prevention Audit
and Waste Managment Options
Are
there practicable
opportunities to re-use,
recycle or treat the
waste?
yes
reject
no
Action List
Is material
acceptable?
no
Can
material be made
acceptable?
no
reject
yes
yes
Identify and characterize
Dumping Site
Determine potential
impacts and prepare
Impact Hypothes(i/e)s
Issue Permit?
no
reject
yes
Implement project and
monitor compliance
Field Monitoring
and Assessment

Fig. 1

.5 Identify and Characterize Dump-site (Chapter 6) (Dump-site Selection)

.6 Determine Potential Impacts and Prepare Impact Hypothesis(es) (Chapter 7) (Assessment of Potential Effects)

.7 Issue Permit (Chapter 9) (Permit and Permit Conditions)

.8 Implement Project and Monitor Compliance (Chapter 8) (Monitoring)

.9 Field Monitoring and Assessment (Chapter 8) (Monitoring).

1.4 These Guidelines[14] refer to "vessels at sea" as specified in Annex I (11)(d) to the London Convention 1972 and in Annex 1(1.4) to the 1996 Protocol. Adherence to the following represents neither a more restrictive nor a less restrictive regime than that of the generic Guidelines of 1997. For purposes of these Guidelines, vessels are defined as any waterborne or airborne craft of any type whatsoever. This includes submersibles, air-cushioned craft and floating craft whether self-propelled or not. The assessment of platforms or other man-made structures at sea is covered in separate specific Guidelines.

1.5 These Guidelines set out the factors to be addressed when considering disposal of vessels at sea, with particular emphasis on the need to evaluate alternatives to sea disposal prior to sea disposal being determined the preferred alternative.

1.6 There are a large number of different types of vessels, which may be considered for disposal in the ocean. Permitting authorities should determine the minimum size vessel to which these Guidelines apply.

2 WASTE PREVENTION AUDIT

2.1 The initial stages in assessing alternatives to dumping should, as appropriate, include an evaluation of the types, amounts and relative hazards of wastes generated (See also chapter 4 below).

2.2 In general terms, if the required audit reveals that opportunities exist for waste prevention at source, an applicant is expected to formulate and implement a waste prevention strategy in collaboration with relevant local and national agencies which includes specific waste reduction targets and provision for further waste prevention audits to ensure that these targets are being met. Permit issuance or renewal decisions shall assure compliance with any resulting waste reduction and prevention requirements. *(Note: This paragraph is not directly pertinent to the disposal of vessels at sea. However, it is important to acknowledge the obligation to take steps to prevent waste arising thereby reducing the need for disposal at sea.)*

3 VESSELS: WASTE MANAGEMENT OPTIONS

3.1 When vessels are no longer needed, there are several options for their disposition, ranging from re-use of the vessel or parts of the vessel, to recycling or scrapping, to final disposal on land or at sea. A comprehensive evaluation of alternatives including engineering/safety, economic, and environmental analyses should be carried out as follows:

.1 re-use of the vessel, or re-use of parts removed from the vessel (e.g., generators, machines, pumps, cranes, and furniture);

.2 recycling (such as use for scrap (e.g., ferrous or non-ferrous metals – copper/aluminium/nickel scrap metals), assuming that proper ship-breaking is taking place under controlled conditions, in a harbour and wharf where de-construction and the collection and disposal of hazardous constituents, such as oils, sludges and other materials, can be managed in an environmentally sound manner);

[14]The Twenty-second Consultative Meeting of Contracting Parties to the London Convention 1972 adopted these specific Guidelines in 2000.

.3 destruction of hazardous constituents using environmentally sound techniques (e.g., in certain cases, on-shore incineration of liquid wastes from the vessel or wastes generated during the cleaning of the vessel);

.4 cleaning of the vessel or its components, removal of components, or treatment in order to reduce or remove the hazardous constituents (such as removal of transformers and storage tanks) and treatment of hazardous constituents, such as oils, sludges and other materials, in an environmentally sound manner; and

.5 disposal on land and into water.

3.2 A permit to dump wastes or other matter shall be refused if the permitting authority determines that appropriate opportunities exist to re-use, recycle or treat the waste without undue risks to human health or the environment or disproportionate costs. The practical availability of other means of disposal should be considered in the light of a comparative risk assessment involving both dumping and the alternatives.

3.3 The comparative risk assessment should take into account factors such as the following:

.1 Potential impact upon the environment:

- effect upon marine habitats and marine communities;
- effects upon other legitimate uses of the sea;
- effect of on-shore re-use, recycling, or disposal, including potential impacts upon land, surface and ground water, and air pollution; and
- effect of energy and materials usage (including overall assessment of energy and materials use and savings) of each of the re-use recycling or disposal options including transportation and resultant impacts to the environment (i.e., secondary impacts);

.2 Potential impact upon human health:

- identification of routes of exposure and analysis of potential impacts upon human health of sea and land re-use, recycling, and disposal options including potential secondary impacts of energy usage; and
- quantification and evaluation of safety risks associated with re-use, recycling and disposal;

.3 Technical and practical feasibility:

- evaluation of the technical and practical feasibility (e.g., evaluation of engineering aspects per specific types and sizes of vessels) for re-use or for ship-breaking and recycling.

.4 Economic considerations:

- analysis of the full cost of vessel re-use, recycling, or disposal alternatives, including secondary impacts; and
- review of costs in view of benefits, such as resource conservation and economic benefits of steel recycling.

4 WASTE CHARACTERIZATION: CHEMICAL/PHYSICAL PROPERTIES

4.1 A pollution prevention plan should be developed that includes specific actions regarding identification of potential sources of pollution. The purpose of this plan is to assure that wastes (or other matter and materials capable of creating floating debris) potentially contributing to pollution of the marine environment have been removed to the maximum extent.

4.2 A detailed description and characterization of the potential sources of contamination (including chemical and biological) is an essential precondition for a decision as to whether a permit may be issued for disposal at sea of a vessel. Characterization by biological or chemical testing is not needed if the required pollution prevention plans are developed and implemented as well as the best environmental practices described below in paragraph 5.2.

4.3 An analysis of the potential for adverse effects to the marine environment from vessels proposed for disposal at sea should take into account characterization of the dump-site including ecological resources and oceanographic characteristics (see chapter 6 of these Guidelines, Dump-site Selection).

4.4 The pollution prevention plan should consider the following:

.1 details of the vessel's operational equipment and potential sources, amounts and relative hazards of potential contaminants (including chemical and biological) that may be released to the marine environment; and

.2 feasibility of the following pollution prevention/reduction techniques:

- cleaning of pipes, tanks, and components of the vessel (including environmentally sound management of resultant wastes); and
- re-use/recycling/disposal of all or some vessel components. Besides ferrous scrap materials, there may be high value components available, such as non-ferrous metals, (e.g., copper, aluminium, nickel) and re-usable equipment such as generators, machines, pumps and cranes. Removal from the vessel for re-use should be based on a balance between their age, condition, demand, and cost of removal.

4.5 The principal components of a vessel (e.g., steel/iron/aluminium) are not an overriding concern from the standpoint of marine pollution. However, there are a number of potential sources of pollution that should be addressed when considering management options. These may include:

.1 fuel, lubricants, and coolants;
.2 electrical equipment;
.3 stored paints, solvents, and other chemical stocks;
.4 floatable materials (e.g., plastics, styrofoam insulation);
.5 sludges;
.6 cargo; and
.7 harmful aquatic organisms.

4.6 Items on vessels that potentially contain substances of concern include:

.1 electrical equipment (e.g., trans-formers, batteries, accumulators);
.2 coolers;
.3 scrubbers;
.4 separators;
.5 heat exchangers;
.6 tanks;
.7 storage facilities for production and other chemicals;
.8 diesel tanks including bulk storage tanks;
.9 paints;
.10 sacrificial anodes;
.11 fire extinguishing/fighting equipment;
.12 piping;
.13 pumps;
.14 engines;
.15 generators;
.16 oil sumps;

.17 tanks;

.18 hydraulic systems;

.19 piping, valves and fittings;

.20 compressors;

.21 light fittings/fixtures; and

.22 cables.

4.7 Materials remaining in tanks, piping, or holds should be removed from the vessel to the maximum extent possible (including, for example, fuel, lubricating oils, hydraulic fluids, cargoes and their residues, and grease). All drummed, tanked, or canned liquids or gaseous materials should be removed from the vessel. All materials removed should be managed on land in an environmentally sound manner (e.g., recycling and, in certain cases, on-shore incineration). Removal of equipment containing liquid PCBs should be a priority.

4.8 As far as practicable, consideration should be given to avoiding the transfer of harmful aquatic organisms, on or in ballast water on board the vessel.

4.9 The standard requirement to characterize wastes and their constituents is not directly pertinent to the disposal of vessels at sea because the general characterization of chemical, physical, and biological properties can be accomplished for vessels without actual chemical or biological testing (see paragraphs 4.1 to 4.7 above and chapter 5 below).

5 DISPOSAL AT SEA: BEST ENVIRONMENTAL PRACTICES (ACTION LIST)

5.1 Contaminants that are likely to cause harm to the marine environment should be removed from vessels prior to disposal at sea. Because vessels disposed at sea should have contaminants removed prior to disposal, action limits for vessels are to be met through the implementation of the pollution prevention plan (see chapter 4) and the best environmental practices (paragraph 5.2), in order to ensure that it has been cleaned to the maximum extent possible. The best environmental practices, specifically identified for vessels in the next paragraph, should be followed.

5.2 The pollution prevention and cleanup techniques described below should be implemented for vessels that are to be disposed at sea. Within technical and economic feasibility and taking into consideration the safety of workers, to the maximum extent, (1) vessels shall be cleaned of potential sources of pollution as described in paragraphs 4.5 - 4.8 above, and of fuel or other substances that are likely to cause harm to the marine environment, and (2) materials capable of creating floating debris shall be removed, as described below. Resulting wastes or materials should be re-used, recycled or disposed on land in an environmentally sound manner, among other measures:

.1 floatable materials that could adversely impact safety, human health, or the ecological or aesthetic value of the marine environment are to be removed;

.2 fuels, stocks of industrial or commercial chemicals, or wastes that may pose an adverse risk to the marine environment are to be removed (including consideration of harmful aquatic organisms);

.3 remove any capacitors and transformers containing dielectric fluid from the vessel to the maximum extent possible;

.4 if any part of the vessel was used for storage of fuel or chemical stocks such as in tanks, these areas shall be flushed, cleaned, and, as appropriate, sealed or plugged; and

.5 to prevent release of substances that could cause harm to the marine environment, cleaning of tanks, pipes and other vessel equipment and surfaces shall be accomplished in an environmentally sound manner prior to disposal using appropriate techniques, such as high pressure washing techniques with detergents. The resulting wash water should be handled in an environmentally sound manner consistent with national or regional standards to address potential pollutants.

6 DUMP-SITE SELECTION

Site selection considerations

6.1 Proper selection of a dump-site at sea for the reception of waste is of paramount importance.

6.2 Information required to select a dump-site shall include:

.1 physical and biological characteristics of the seabed and surrounding area, and oceanographic characteristics of the general area in which the site is to be located;

.2 consideration of the potential implications of the vessel's presence on amenities, values and other uses of the sea in the area of consideration;

.3 assessment of the constituent fluxes associated with dumping in relation to existing fluxes of substances in the marine environment; and

.4 economic and operational feasibility.

6.3 Guidance for procedures to be followed in dump-site selection can be found in a report of the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP Reports and Studies No. 16 - Scientific Criteria for the Selection of Waste Disposal Sites at Sea). Prior to selecting a dump-site, it is essential that data be available on the oceanographic characteristics of the general area in which the site is to be located. This information can be obtained from the literature but fieldwork should be undertaken to fill the gaps. The information requirements for the selection of a site for disposal of vessels are much less rigorous in terms of oceanographic characteristics but do include that information found in paragraph 6.4. Generally, required information includes:

.1 the nature of the seabed, including its topography, geo-chemical and geological characteristics, its biological composition and activity, identification of hard or soft bottom habitats, and prior dumping activities affecting the area;

.2 the physical nature of the water column, including temperature, depth, possible existence of a thermocline/pycnocline and how it varies in depth with season and weather conditions, tidal period and orientation of the tidal ellipse, mean direction and velocity of the surface and bottom drifts, velocities of storm-wave induced bottom currents, general wind and wave characteristics, and the average number of storm days per year, suspended matter; and

.3 the chemical and biological nature of the water column, including pH, salinity, dissolved oxygen at surface and bottom, chemical and biochemical oxygen demand, nutrients and their various forms and primary productivity.

6.4 Some of the important amenities, biological features and uses of the sea to be considered in determining the specific location of the dump-site are:

.1 the shoreline and bathing beaches;

.2 areas of beauty or significant cultural or historical importance;

.3 areas of special scientific or biological importance, such as sanctuaries;

.4 fishing areas;

.5 spawning, nursery and recruitment areas;

.6 migration routes;

.7 seasonal and critical habitats;

.8 shipping lanes;

.9 military exclusion zones; and

.10 engineering uses of the seafloor, including mining, undersea cables, desalination or energy conversion sites.

Size of the dump-site

6.5 Size of the dump-site is an important consideration for anticipating the possible disposal of more than one vessel at the site:

.1 it should be large enough to have the bulk of the material remain either within the site limits or within a predicted area of impact after dumping;

.2 it should be large enough in relation to anticipated volumes for dumping so that it would serve its function for many years; and

.3 it should not be so large that monitoring would require undue expenditure of time and money.

Site capacity

6.6 In order to assess the capacity of a site, especially for solid wastes, the following should be taken into consideration:

.1 the anticipated loading rates per day, week, month or year;

.2 whether or not it is a dispersive site; and

.3 the allowable reduction in water depth over the site because of mounding of material.

Evaluation of potential impacts

6.7 An important consideration in determining the suitability for sea disposal of vessels at a specific site is to predict the extent to which there may be impacts on existing and adjacent habitats and marine communities (e.g., coral reefs and soft bottom communities).

(Note: Paragraphs 6.8 to 6.13 below are concerns about impacts, but if the pollution prevention plan (see chapter 4) and the best environmental practices (see paragraph 5.2 above) are followed, these paragraphs are not directly pertinent.)

6.8 The extent of adverse effects of a substance is a function of the exposures of organisms (including humans). Exposure, in turn, is a function, *inter alia*, of input flux and the physical, chemical and biological processes that control the transport, behaviour, fate and distribution of a substance.

6.9 The presence of natural substances and the ubiquitous occurrence of contaminants means that there will always be some pre-existing exposures of organisms to all substances contained in any waste that might be dumped. Concerns about exposures to hazardous substances thus relate to additional exposures as a consequence of dumping. This, in turn, can be translated back to the relative magnitude of the input fluxes of substances from dumping compared with existing input fluxes from other sources.

6.10 Accordingly, due consideration needs to be given to the relative magnitude of the substance fluxes associated with dumping in the local and regional area surrounding the dump-site. In cases where it is predicted that dumping will substantially augment existing fluxes associated with natural processes, dumping at the site under consideration should be deemed inadvisable.

6.11 In the case of synthetic substances, the relationship between fluxes associated with dumping and pre-existing fluxes in the vicinity of the site may not provide a suitable basis for decisions.

6.12 Temporal characteristics should be considered to identify potentially critical times of the year (e.g., for marine life) when dumping should not take place. This consideration leaves periods when it is expected that dumping operations will have less impact than at other times. If these restrictions become too burdensome and costly, there should be some opportunity for compromise in which priorities may have to be established concerning species to be left wholly undisturbed. Examples of such biological considerations are:

.1 periods when marine organisms are migrating from one part of the ecosystem to another (e.g., from an estuary to open sea or vice versa) and growing and breeding periods;

.2 periods when marine organisms are hibernating on or are buried in the sediments; and

.3 periods when particularly sensitive and possibly endangered species are exposed.

Contaminant mobility

6.13 Contaminant mobility is dependent upon several factors, among which are:

.1 type of matrix;

.2 form of contaminant;

.3 contaminant partitioning;

.4 physical state of the system, e.g., temperature, water flow, suspended matter;

.5 physico-chemical state of the system;

.6 length of diffusion and advection pathways; and

.7 biological activities e.g., bioturbation.

7 ASSESSMENT OF POTENTIAL EFFECTS

7.1 Assessment of potential effects should lead to a concise statement of the expected consequences of the sea or land disposal options, i.e., the "Impact Hypothesis". It provides a basis for deciding whether to approve or reject the proposed disposal option and for defining environmental monitoring requirements. As far as possible, waste management options causing dispersion and dilution of contaminants in the environment should be avoided and preference given to techniques that prevent the input of the contaminants to the environment.

7.2 The assessment of disposal options should integrate information on vessel characteristics and conditions at the proposed dump-site, specify the economic and technical feasibility of the options being considered, and evaluate the potential effects on human health, living resources, amenities, other legitimate uses of the sea, and the environment in general. For vessels, this assessment should be based upon the underlying premise that with implementation of the pollution prevention plan in chapter 4 and of best environmental practices in paragraph 5.2, any adverse impacts will be minimized and will primarily be those resulting from the physical presence of the vessel on the sea floor because the disposed vessels will have had contaminants removed to the maximum extent.

7.3 The assessment should be as comprehensive as possible. The primary potential impacts should be identified during the dump-site selection process. These are considered to pose the most serious threats to human health and the environment. Alterations to the physical environment, risks to human health, devaluation of marine resources and interference with other legitimate uses of the sea are often seen as primary concerns in this regard.

7.4 In constructing an impact hypothesis, particular attention should be given to, but not limited to, potential impacts on amenities (e.g., presence of floatables), sensitive areas (e.g., spawning, nursery or feeding areas), habitat (e.g., biological, chemical and physical modification), migratory patterns and marketability of resources. Consideration should also be given to potential impacts on other uses of the sea including: fishing, navigation, engineering uses, areas of special concern and value, and traditional uses of the sea.

(Note to paragraphs 7.5 to 7.8 below: The disposal of vessels at sea, where the "waste" is a solid, does not present the same types of potential environmental concerns as the disposal of other wastes, such as liquids, where the waste materials can be readily distributed into the environment; and thereby does not necessarily fit the standard paradigm of rigorous biological or chemical monitoring due to contaminants in the waste. Potential sources of pollution as described above in paragraphs 4.5 to 4.8, other substances that are likely to cause harm to the environment, and materials capable of creating floating debris shall be removed to the maximum extent possible prior to disposal. When developing the monitoring plan, these factors should be considered.)

7.5 Even the least complex and most innocuous wastes may have a variety of physical, chemical and biological effects. Impact hypotheses cannot attempt to reflect them all. It must be recognized that even the most comprehensive impact hypotheses may not address all possible scenarios such as unanticipated impacts. It is therefore imperative that the monitoring programme be linked directly to the hypotheses and serve as a feedback mechanism to verify the predictions and review the adequacy of management measures applied to the dumping operation and at the dump-site. It is important to identify the sources and consequences of uncertainty.

7.6 The expected consequences of dumping should be described in terms of affected habitats, processes, species, communities and uses. The precise nature of the predicted effect (e.g., change, response, or interference) should be described. The effect should be quantified in sufficient detail so that there would be no doubt as to the variables to be measured during field monitoring. In the latter context, it would be essential to determine "where" and "when" the impacts can be expected.

7.7 Emphasis should be placed on biological effects and habitat modification as well as physical and chemical change. However, if the potential effect is due to substances, the following factors should be addressed:

.1 estimates of statistically significant increases of the substance in seawater, sediments, or biota in relation to existing conditions and associated effects; and

.2 estimate of the contribution made by the substance to local and regional fluxes and the degree to which existing fluxes pose threats or adverse effects on the marine environment or human health.

7.8 In the case of repeated or multiple dumping operations, impact hypotheses should take into account the cumulative effects of such operations. It will also be important to consider the possible interactions with other waste dumping practices in the area, both existing or planned.

7.9 An analysis of each disposal option should be considered in light of a comparative assessment of the following concerns: human health risks, environmental costs, hazards (including accidents), economics and exclusion of future uses. If this assessment reveals that adequate information is not available to determine the likely effects of the proposed disposal option, including potential long-term harmful consequences, then this option should not be considered further. In addition, if the interpretation of the comparative assessment shows the dumping option to be less preferable, a permit for dumping should not be given.

7.10 Each assessment should conclude with a statement supporting a decision to issue or refuse a permit for dumping.

7.11 Where monitoring is required, the effects and parameters described in the hypotheses should help to guide field and analytical work so that relevant information can be obtained in the most efficient and cost-effective manner.

8 MONITORING

8.1 Monitoring is used to verify that permit conditions are met - compliance monitoring - and that the assumptions made during the permit review and site selection process were correct and sufficient to protect the environment and human health - field monitoring. It is essential that such monitoring programmes have clearly defined objectives.

8.2 The Impact Hypothesis forms the basis for defining field monitoring. The measurement programme should be designed to ascertain that changes in the receiving environment are within those predicted. The following questions must be answered:

.1 What testable hypotheses can be derived from the Impact Hypothesis?

.2 What measurements (type, location, frequency, performance requirements) are required to test these hypotheses?

.3 How should the data be managed and interpreted?

8.3 It may usually be assumed that suitable specifications of existing (pre-disposal) conditions in the receiving area are already contained in the application for dumping. If the specification of such conditions is inadequate to permit the formulation of an Impact Hypothesis, the licensing authority will require additional information before any final decision on the permit application is made.

8.4 The permitting authority is encouraged to take account of relevant research information in the design and modification of monitoring programmes. The measurements can be divided into two types - those within the zone of predicted impact and those outside.

8.5 Measurements should be designed to determine whether the zone of impact and the extent of change outside the zone of impact differ from those predicted. The former can be answered by designing a sequence of measurements in space and time that ensures that the projected spatial scale of change is not exceeded. The latter can be answered by the acquisition of measurements that provide information on the extent of change that occurs outside the zone of impact as a result of the dumping operation. Frequently, these measurements will be based on a null hypothesis - that no significant change can be detected.

8.6 The results of monitoring (or other related research) should be reviewed at regular intervals in relation to the objectives and can provide a basis to:

.1 modify or terminate the field-monitoring programme;

.2 modify or revoke the permit;

.3 redefine or close the dump-site; and

.4 modify the basis on which applications to dump wastes are assessed.

9 PERMIT AND PERMIT CONDITIONS

9.1 The permitting process should include the following essential elements: (1) a description of the best environmental practices (see paragraph 5.2) for the disposal option selected; (2) cleaning of the vessel; (3) inspection/verification by relevant authorities that adequate cleaning has taken place; and (4) permit issuance. The national permitting authority should ensure that the appropriate hydrographic surveying authority is notified of the longitude and latitude co-ordinates, depth, and dimensions of the dumped vessel on the sea bottom. The national permitting authority should also ensure that advance notice of the dumping is issued to national shipping, fisheries, and hydrographic surveying authorities. Any permit issued shall contain data and information specifying:

.1 name, type, or tonnage of the vessel;

.2 the location of the dump-site(s);

.3 the method of dumping; and

.4 monitoring and reporting requirements.

9.2 If dumping is the selected option, then a permit authorizing dumping must be issued in advance. It is recommended that opportunities be provided for public review and participation in the permitting process. In granting a permit, the hypothesized impact occurring within the boundaries of the dump-site, such as alterations to the physical, chemical and biological compartments of the local environment is accepted by the permitting authority.

9.3 Regulators should strive at all times to enforce procedures that will result in environmental changes as far below the limits of allowable environmental change as practicable, taking into account technological capabilities as well as economic, social and political concerns.

9.4 Permits should be reviewed at regular intervals, taking into account the results of monitoring and the objectives of monitoring programmes. Review of monitoring results will indicate whether field programmes need to be continued, revised or terminated, and will contribute to informed decisions regarding the continuance, modification or revocation of permits. This provides an important feedback mechanism for the protection of human health and the marine environment.

SPECIFIC GUIDELINES FOR ASSESSMENT OF PLATFORMS OR OTHER MAN-MADE STRUCTURES AT SEA

1 INTRODUCTION

1.1 The Guidelines for the Assessment of Wastes or Other Matter that May be Considered for Dumping,[15] referred to in short as the "Generic Guidelines", as well as the Specific Guidelines for Assessment of Platforms or Other Man-Made Structures at Sea addressed in this document are intended for use by national authorities responsible for regulating dumping of wastes and embody a mechanism to guide national authorities in evaluating applications for dumping of wastes in a manner consistent with the provisions of the London Convention 1972 or the 1996 Protocol thereto. Annex 2 to the 1996 Protocol places emphasis on progressively reducing the need to use the sea for dumping of wastes. Furthermore, it recognizes that avoidance of pollution demands rigorous controls on the emission and dispersion of contaminating substances and the use of scientifically based procedures for selecting appropriate options for waste disposal. When applying these Guidelines uncertainties in relation to assessments of impacts on the marine environment will need to be considered and a precautionary approach applied in addressing these uncertainties. They should be applied with a view that acceptance of dumping under certain circumstances does not remove the obligation to make further attempts to reduce the necessity for dumping.

1.2 The 1996 Protocol to the London Convention 1972 follows an approach under which dumping of wastes or other matter is prohibited except for those materials specifically enumerated in Annex I, and in the context of that Protocol, these Guidelines would apply to the materials listed in that Annex. The London Convention 1972 prohibits the dumping of certain wastes or other matter specified therein and in the context of that Convention these Guidelines meet the requirements of its Annexes for wastes not prohibited for dumping at sea. When applying these Guidelines under the London Convention 1972, they should not be viewed as a tool for the reconsideration of dumping of wastes or other matter in contravention of Annex I to the London Convention 1972.

1.3 The schematic shown in Figure 1 provides a clear indication of the stages in the application of the Guidelines where important decisions should be made and is not designed as a conventional "decision tree". In general, national authorities should use the schematic in an iterative manner ensuring that all steps receive consideration before a decision is made to issue a permit. Figure 1 illustrates the relationship between the operational components of Annex 2 of the 1996 Protocol and contains the following elements:

.1 Waste Prevention Audit (Chapter 2)

.2 Platforms/Structures: Waste Management Options (Chapter 3)

.3 Waste Characterization: Chemical/Physical Properties (Chapter 4)

.4 Disposal at Sea: Best Environmental Practices (Chapter 5) – (Action List)

.5 Identify and Characterize Dump-site(Chapter 6) (Dump-site Selection)

.6 Determine Potential Impacts and Prepare Impact Hypothesis(es) (Chapter 7) (Assessment of Potential Effects)

.7 Issue Permit (Chapter 9) (Permit and Permit Conditions)

.8 Implement Project and Monitor Compliance (Chapter 8) (Monitoring)

.9 Field Monitoring and Assessment (Chapter 8) (Monitoring).

[15] The Nineteenth Consultative Meeting of Contracting Parties to the London Convention 1972 adopted these Guidelines in 1997.

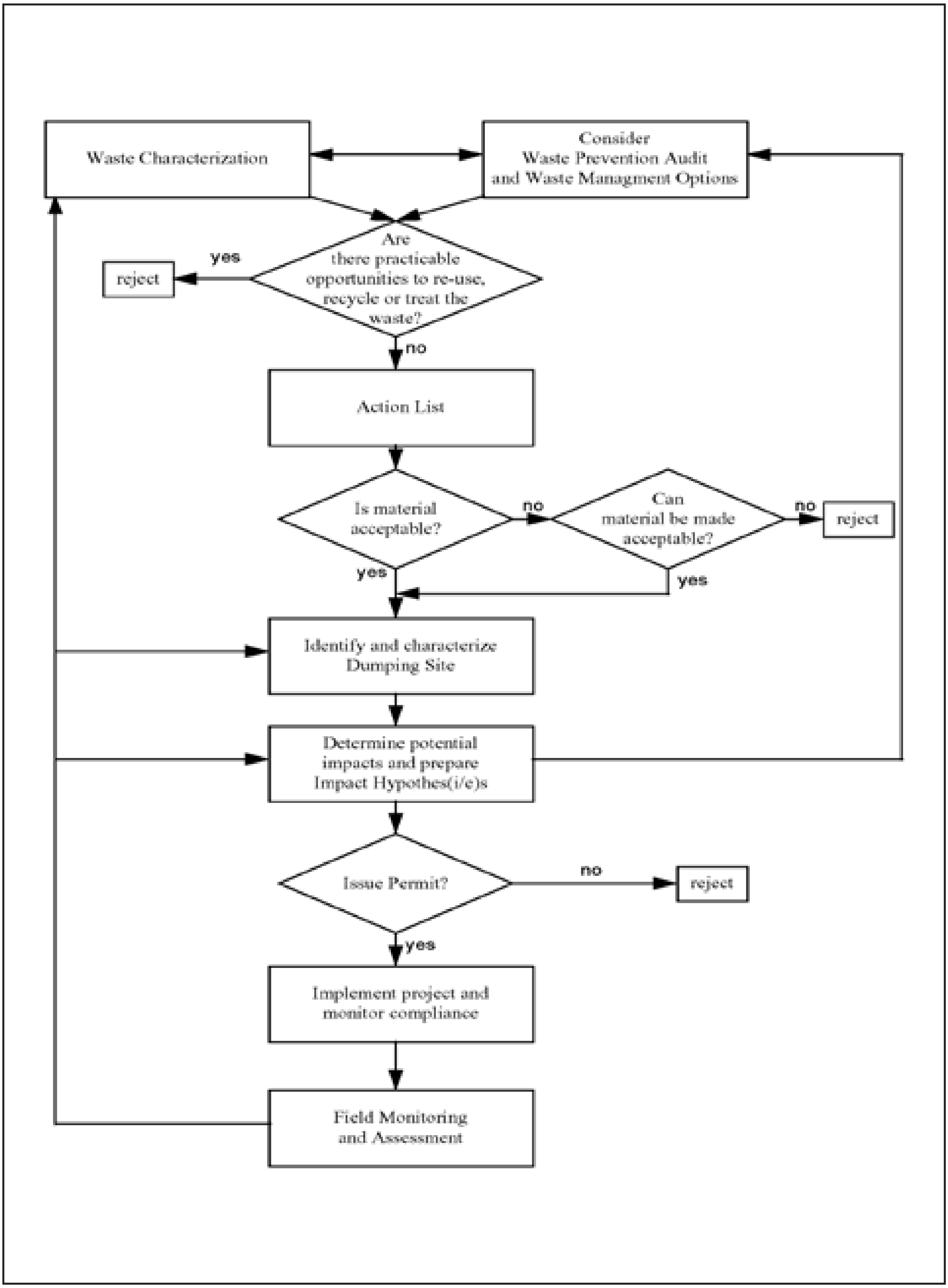
Waste Characterization
Consider
Waste Prevention Audit
and Waste Managment Options
Are
there practicable
opportunities to re-use,
recycle or treat the
waste?
yes
reject
no
Action List
Is material
acceptable?
no
Can
material be made
acceptable?
no
reject
yes
yes
Identify and characterize
Dumping Site
Determine potential
impacts and prepare
Impact Hypothes(i/e)s
Issue Permit?
no
reject
yes
Implement project and
monitor compliance
Field Monitoring
and Assessment

Fig. 1

1.4 These Guidelines[16] refer to "....platforms or other man-made structures at sea" as specified in Annex I (11) to the London Convention 1972 and in Annex 1(1.4) to the 1996 Protocol. Adherence to the following represents neither a more restrictive nor a less restrictive regime than that of the generic Guidelines of 1997. However, much of these specific Guidelines are targeted specifically to oil and gas platforms, since these platforms are likely to constitute the majority of platforms and other man-made structures that may be considered for disposal at sea. Consideration of other types of platforms or man-made structures should involve similar assessments as conducted for oil and gas platforms in determining if a permit should be issued for sea disposal.

1.5 These Guidelines set out the factors to be addressed when considering disposal of platforms or other man-made structures at sea, with particular emphasis on the need to evaluate alternatives to sea disposal prior to sea disposal being determined the preferred alternative.

1.6 For purposes of these Guidelines, platforms are defined as facilities designed and operated for the purpose of producing, processing, storing, or supporting the production of mineral resources.

1.7 The category of "other man-made structures at sea" is not defined under the London Convention 1972 nor under the 1996 Protocol but could include lighthouses, buoys, and offshore transfer facilities. The assessment of vessels at sea is covered in separate specific Guidelines.

2 WASTE PREVENTION AUDIT

2.1 The initial stages in assessing alternatives to dumping should, as appropriate, include an evaluation of the types, amounts and relative hazards of wastes generated (See also chapter 4 below).

2.2 In general terms, if the required audit reveals that opportunities exist for waste prevention at source, an applicant is expected to formulate and implement a waste prevention strategy in collaboration with relevant local and national agencies which includes specific waste reduction targets and provision for further waste prevention audits to ensure that these targets are being met. Permit issuance or renewal decisions shall assure compliance with any resulting waste reduction and prevention requirements. *(Note: This paragraph is not directly pertinent to the disposal of platforms or other man-made structures at sea. However, it is important to acknowledge the obligation to take steps to prevent waste arising thereby reducing the need for disposal at sea.)*

3 PLATFORMS/STRUCTURES: WASTE MANAGEMENT OPTIONS

3.1 When platforms or other man-made structures are no longer needed, there are several options for their disposition, ranging from re-use at sea or on shore, to recycling or scrapping, to final disposal on land or at sea. Topsides, containing the production, processing, power plant/machinery, storage, transportation, and accommodation facilities, are generally taken ashore for recycling or re-use.

3.2 Applications to dispose of platforms or other man-made structures at sea shall demonstrate that consideration has been given to a number of different management options. In general, preparing the platform for disposal at sea involves planning and conducting shutdown operations on an oil or gas platform and the re-use, recycling, or disposal of the platform. Applying a hierarchy of waste management options, the basic steps include the following:

.1 planning, including engineering/safety, economic, and environmental analyses;

.2 removing all or part of the platform from the site;

.3 re-using, recycling, or disposing those parts removed from the site;

[16] The Twenty-second Consultative Meeting of Contracting Parties to the London Convention 1972 adopted these specific Guidelines in 2000.

.4 cleaning, where needed, of parts not removed; and

.5 site clearance, as appropriate.

3.3 A permit to dump wastes or other matter shall be refused if the permitting authority determines that appropriate opportunities exist to re-use, recycle or treat the waste without undue risks to human health or the environment or disproportionate costs. The practical availability of other means of disposal should be considered in the light of a comparative risk assessment involving both dumping and the alternatives.

3.4 The comparative risk assessment should take into account factors such as the following:

.1 Potential impact upon the environment:

- effect upon marine habitats and marine communities;
- effects upon other legitimate uses of the sea;
- effect of onshore re-use, recycling, or disposal, including potential impacts upon land, surface and ground water, and air pollution; and
- effect of energy and materials usage (including overall assessment of energy and materials use and savings) of each of the re-use, recycling or disposal options including transportation and resultant impacts to the environment (i.e., secondary impacts);

.2 Potential impact upon human health:

- identification of routes of exposure and analysis of potential impacts of sea and land re-use, recycling, and disposal options including potential secondary impacts of energy usage; and
- quantification and evaluation of safety risks associated with onshore re-use, recycling, and disposal, and disposal at sea;

.3 Technical and practical feasibility:

- evaluation of engineering capabilities per specific types, sizes, and weights of platforms; and
- identification of practical limitations of disposal alternatives considering characteristics of the platform and oceanographic considerations;

.4 Economic considerations:

- analysis of the full cost of platform re-use, recycling, or disposal alternatives, including secondary impacts; and
- review of costs in view of benefits, such as resource conservation and economic benefits of steel recycling.

4 WASTE CHARACTERIZATION CHEMICAL AND PHYSICAL PROPERTIES

4.1 A pollution prevention plan should be developed that includes specific actions regarding identification of potential sources of pollution. The purpose of this plan is to assure that wastes (or other matter and materials capable of creating floating debris) contributing to pollution of the marine environment have been removed to the maximum extent.

4.2 A detailed description and characterization of the potential sources of contamination is an essential precondition for a decision as to whether a permit may be issued for disposal at sea of a platform or other man-made structure. Characterization by biological or chemical testing is not needed if the required pollution prevention plans are developed and implemented as well as the best environmental practices described in paragraph 5.2.

4.3 An analysis of the potential for adverse effects to the marine environment from platforms or other man-made structures proposed for disposal at sea should take into account characterization of the disposal site including ecological resources and oceanographic characteristics (see chapter 6 of these Guidelines, Dump-site Selection).

4.4 The pollution prevention plan should consider the following:

- .1 the platform/structure production, processing, and transportation facilities in regard to potential sources, amounts and relative potential hazards of wastes; and
- .2 feasibility of the following pollution prevention/reduction techniques:
  - cleaning of pipes, tanks, and structures (including environmentally sound management of resultant wastes); and
  - re-use, recycling, disposal on land of all or some platform components with special attention to topsides and its components.

4.5 The principal components of a platform or other man-made structure (steel and concrete) are not an overriding concern from the standpoint of marine pollution. In the case of platforms, however, there are a number of potential sources of pollution that should be addressed when considering management options. These are associated with platform production processes and related operations and may include:

- .1 the quantities of hydrocarbons, low specific activity scale, and other contaminants in pipe work and tankage, including drilling mud holding/reprocessing tanks;
- .2 stocks of chemicals used in connection with oil and gas production, e.g., corrosion inhibitors, biocides, defoamers, and de-emulsifiers;
- .3 lubricants and coolants in platform equipment; and
- .4 fuel.

4.6 Items on platforms that potentially contain substances of concern include:

- .1 electrical equipment (e.g., transformers, batteries, accumulators);
- .2 coolers;
- .3 scrubbers;
- .4 separators;
- .5 heat exchangers;
- .6 tanks for drilling consumables including bulk storage of muds;
- .7 storage facilities for production and other chemicals;
- .8 diesel tanks including bulk storage tanks;
- .9 paints;
- .10 sacrificial anodes;
- .11 fire extinguishing/fighting equipment;
- .12 piping;
- .13 pumps;
- .14 engines;
- .15 generators;
- .16 oil sumps;
- .17 tanks;
- .18 hydraulic systems;
- .19 tubing and drill string;
- .20 gas dehydrators;
- .21 gas-sweetening units;

.22 helicopter fuelling systems;

.23 piping, valves and fittings;

.24 compressors; and

.25 insulations systems.

4.7 The evaluation of potential sources of pollution from other man-made structures should include an appropriate assessment similar to the general considerations in the paragraphs 4.1 to 4.6 above for platforms.

4.8 The standard requirement to characterize wastes and their constituents is not directly pertinent to the disposal of platforms/structures at sea because the general characterization of chemical, physical, and biological properties can be accomplished for platforms/structures without actual chemical or biological testing (see paragraphs 4.1 to 4.6 above and chapter 5 below).

5 DISPOSAL AT SEA: BEST ENVIRONMENTAL PRACTICES (ACTION LIST)

5.1 Contaminants that are likely to cause harm to the marine environment should be removed from the platforms/structures prior to disposal at sea. Because platforms/structures disposed at sea should have contaminants removed prior to disposal, action limits for platforms/structures are to be met through the implementation of the pollution prevention plan (see chapter 4) and the best environmental practices (paragraph 5.2), in order to ensure that it has been cleaned to the maximum extent possible. The best environmental practices, specifically identified for platforms/structures in the next paragraph, should be followed.

5.2 The pollution prevention and cleanup techniques described below should be implemented for platforms/structures that are to be disposed at sea. Within technical and economic feasibility and taking into consideration the safety of workers, to the maximum extent, (1) platforms/structures shall be cleaned of petroleum hydrocarbons or other substances that are likely to cause harm to the marine environment, and (2) materials capable of creating floating debris shall be removed, as described below:

.1 floatable materials that could adversely impact safety, human health, or the ecological or aesthetic value of the marine environment are to be removed;

.2 hydrocarbons, stocks of industrial or commercial chemicals, drilling muds, or wastes that may pose an adverse risk to the marine environment are to be removed;

.3 if any part of the platform jacket was used for storage of hydrocarbons or chemical stocks such as in tanks integrated into the legs of the jacket, these areas shall be flushed, cleaned and, as appropriate, sealed or plugged; and

.4 to prevent the release of substances that could cause harm to the marine environment, cleaning of tanks, pipes and other platform equipment and surfaces shall be accomplished in an environmentally sound manner prior to disposal using appropriate techniques, such as high pressure washing techniques with detergents. The resulting wash water should either be taken ashore for treatment or be treated offshore consistent with national or regional standards to address potential pollutants.

5.3 While outside the jurisdiction of this guidance, the vicinity of the platform or other man-made structure should be cleared of debris that may interfere with other legitimate uses of the sea, within reasonable and technically feasible expectations.

6 DUMP-SITE SELECTION

Site selection considerations

6.1 Proper selection of a dump-site at sea for the reception of waste is of paramount importance.

6.2 Information required to select a dump-site shall include:

.1 physical and biological characteristics of the seabed and surrounding area, including the potential for providing environmental benefits, and oceanographic characteristics of the general area in which the site is to be located;

.2 location of amenities, values and other uses of the sea in the area under consideration;

.3 assessment of the constituent fluxes associated with dumping in relation to existing fluxes of substances in the marine environment; and

.4 economic and operational feasibility.

6.3 Guidance for procedures to be followed in dump-site selection can be found in a report of the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP Reports and Studies No. 16 - Scientific Criteria for the Selection of Waste Disposal Sites at Sea). Prior to selecting a dump-site, it is essential that data be available on the oceanographic characteristics of the general area in which the site is to be located. This information can be obtained from the literature but fieldwork should be undertaken to fill the gaps. The information requirements for the selection of a site for disposal of platforms/structures are much less rigorous in terms of oceanographic characteristics but do include that information found in paragraph 6.4. Generally, required information includes:

.1 the nature of the seabed, including its topography, geo-chemical and geological characteristics, its biological composition and activity, identification of hard or soft bottom habitats, and prior dumping activities affecting the area;

.2 the physical nature of the water column, including temperature, depth, possible existence of a thermocline/pycnocline and how it varies in depth with season and weather conditions, tidal period and orientation of the tidal ellipse, mean direction and velocity of the surface and bottom drifts, velocities of storm-wave induced bottom currents, general wind and wave characteristics, and the average number of storm days per year, suspended matter; and

.3 the chemical and biological nature of the water column, including pH, salinity, dissolved oxygen at surface and bottom, chemical and biochemical oxygen demand, nutrients and their various forms and primary productivity.

6.4 Some of the important amenities, biological features and uses of the sea to be considered in determining the specific location of the dump-site are:

.1 the shoreline and bathing beaches;

.2 areas of beauty or significant cultural or historical importance;

.3 areas of special scientific or biological importance, such as sanctuaries;

.4 fishing areas;

.5 spawning, nursery and recruitment areas;

.6 migration routes;

.7 seasonal and critical habitats;

.8 shipping lanes;

.9 military exclusion zones; and

.10 engineering uses of the seafloor, including mining, undersea cables, desalination or energy conversion sites.

Size of the dump-site

6.5 Size of the dump-site is an important consideration for anticipating the possible disposal of more than one platform at the site:

.1 it should be large enough to have the bulk of the material remain either within the site limits or within a predicted area of impact after dumping;

.2 it should be large enough in relation to anticipated volumes for dumping so that it would serve its function for many years; and

.3 it should not be so large that monitoring would require undue expenditure of time and money.

Site capacity

6.6 In order to assess the capacity of a site, especially for solid wastes, the following should be taken into consideration:

.1 the anticipated loading rates per day, week, month or year;

.2 whether or not it is a dispersive site; and

.3 the allowable reduction in water depth over the site because of mounding of material.

Evaluation of potential impacts

6.7 An important consideration in determining the suitability for sea disposal of platforms or other man-made structures at a specific site is to predict the extent to which there may be impacts on existing and adjacent habitats and marine communities (e.g., coral reefs and soft bottom communities).

(Note: Paragraphs 6.8 to 6.13 below are concerns about impacts, but if the pollution prevention plan (see chapter 4) and the best environmental practices (see paragraph 5.2 above) were followed, these paragraphs are not directly pertinent.)

6.8 The extent of adverse effects of a substance is a function of the exposures of organisms (including humans). Exposure, in turn, is a function, *inter alia*, of input flux and the physical, chemical and biological processes that control the transport, behaviour, fate and distribution of a substance.

6.9 The presence of natural substances and the ubiquitous occurrence of contaminants means that there will always be some pre-existing exposures of organisms to all substances contained in any waste that might be dumped. Concerns about exposures to hazardous substances thus relate to additional exposures as a consequence of dumping. This, in turn, can be translated back to the relative magnitude of the input fluxes of substances from dumping compared with existing input fluxes from other sources.

6.10 Accordingly, due consideration needs to be given to the relative magnitude of the substance fluxes associated with dumping in the local and regional area surrounding the dump-site. In cases where it is predicted that dumping will substantially augment existing fluxes associated with natural processes, dumping at the site under consideration should be deemed inadvisable.

6.11 In the case of synthetic substances, the relationship between fluxes associated with dumping and pre-existing fluxes in the vicinity of the site may not provide a suitable basis for decisions.

6.12 Temporal characteristics should be considered to identify potentially critical times of the year (e.g., for marine life) when dumping should not take place. This consideration leaves periods when it is expected that dumping operations will have less impact than at other times. If these restrictions become too burdensome and costly, there should be some opportunity for compromise in which priorities may have to be established concerning species to be left wholly undisturbed. Examples of such biological considerations are:

.1 periods when marine organisms are migrating from one part of the ecosystem to another (e.g., from an estuary to open sea or vice versa) and growing and breeding periods;

.2 periods when marine organisms are hibernating on or are buried in the sediments; and

.3 periods when particularly sensitive and possibly endangered species are exposed.

Contaminant mobility

6.13 Contaminant mobility is dependent upon several factors, among which are:

.1 type of matrix;

.2 form of contaminant;

.3 contaminant partitioning;

.4 physical state of the system, e.g., temperature, water flow, suspended matter;

.5 physico-chemical state of the system;

.6 length of diffusion and advection pathways; and

.7 biological activities e.g., bioturbation.

7 ASSESSMENT OF POTENTIAL EFFECTS

7.1 Assessment of potential effects should lead to a concise statement of the expected consequences of the sea or land disposal options, i.e., the "Impact Hypothesis". It provides a basis for deciding whether to approve or reject the proposed disposal option and for defining environmental monitoring requirements. As far as possible, waste management options causing dispersion and dilution of contaminants in the environment should be avoided and preference given to techniques that prevent the input of the contaminants to the environment.

7.2 The assessment of disposal options should integrate information on platform and other man-made structure characteristics and conditions at the proposed dump-site, specify the economic and technical feasibilities of the options being considered, and evaluate the potential effects on human health, living resources, amenities, other legitimate uses of the sea, and the environment in general. For platforms or other man-made structures, this assessment should be based upon the underlying premise that with implementation of the pollution prevention plan in chapter 4 and of best environmental practices in paragraph 5.2, any adverse impacts will be minimized and will be limited to those resulting from the physical presence of the platform/structure on the sea floor because the disposed platforms/structures will essentially be composed primarily of steel and, in certain instances, concrete.

7.3 The assessment should be as comprehensive as possible. The primary potential impacts should be identified during the dump-site selection process. These are considered to pose the most serious threats to human health and the environment. Alterations to the physical environment, risks to human health, devaluation of marine resources and interference with other legitimate uses of the sea are often seen as primary concerns in this regard.

7.4 In constructing an impact hypothesis, particular attention should be given to, but not limited to, potential impacts on amenities (e.g., presence of floatables), sensitive areas (e.g., spawning, nursery or feeding areas), habitat (e.g., biological, chemical and physical modification), migratory patterns and marketability of resources. Consideration should also be given to potential impacts on other uses of the sea including: fishing, navigation, engineering uses, areas of special concern and value, and traditional uses of the sea.

(Note to paragraphs 7.5 to 7.8 below: The disposal of platforms/structures at sea, where the "waste" is a solid, does not present the same types of potential environmental concerns as the disposal of other wastes, such as liquids, where the waste materials can be readily distributed into the environment; and thereby does not necessarily fit the standard paradigm of rigorous biological or chemical monitoring due to contaminants in the waste. Significant sources of potential contaminants should be removed from the platforms/structures prior to disposal. When developing the monitoring plan, these factors should be considered.)

7.5 Even the least complex and most innocuous wastes may have a variety of physical, chemical and biological effects. Impact hypotheses cannot attempt to reflect them all. It must be recognized that even the most comprehensive impact hypotheses may not address all possible scenarios such as unanticipated impacts. It is therefore imperative that the monitoring programme be linked directly to the hypotheses and serve as a feedback mechanism to verify the predictions and review the adequacy of management measures applied to the dumping operation and at the dump-site. It is important to identify the sources and consequences of uncertainty.

7.6 The expected consequences of dumping should be described in terms of affected habitats, processes, species, communities and uses. The precise nature of the predicted effect (e.g., change, response, or interference) should be described. The effect should be quantified in sufficient detail so that there would be no doubt as to the variables to be measured during field monitoring. In the latter context, it would be essential to determine "where" and "when" the impacts can be expected.

7.7 Emphasis should be placed on biological effects and habitat modification as well as physical and chemical change. However, if the potential effect is due to substances, the following factors should be addressed:

.1 estimates of statistically significant increases of the substance in seawater, sediments, or biota in relation to existing conditions and associated effects; and

.2 estimate of the contribution made by the substance to local and regional fluxes and the degree to which existing fluxes pose threats or adverse effects on the marine environment or human health.

7.8 In the case of repeated or multiple dumping operations, impact hypotheses should take into account the cumulative effects of such operations. It will also be important to consider the possible interactions with other waste dumping practices in the area, both existing or planned.

7.9 An analysis of each disposal option should be considered in light of a comparative assessment of the following concerns: human health risks, environmental costs, hazards (including accidents), economics and exclusion of future uses. If this assessment reveals that adequate information is not available to determine the likely effects of the proposed disposal option, including potential long-term harmful consequences, then this option should not be considered further. In addition, if the interpretation of the comparative assessment shows the dumping option to be less preferable, a permit for dumping should not be given.

7.10 Each assessment should conclude with a statement supporting a decision to issue or refuse a permit for dumping.

7.11 Where monitoring is required, the effects and parameters described in the hypotheses should help to guide field and analytical work so that relevant information can be obtained in the most efficient and cost-effective manner.

8 MONITORING

8.1 Monitoring is used to verify that permit conditions are met - compliance monitoring - and that the assumptions made during the permit review and site selection process were correct and sufficient to protect the environment and human health - field monitoring. It is essential that such monitoring programmes have clearly defined objectives.

8.2 The Impact Hypothesis forms the basis for defining field monitoring. The measurement programme should be designed to ascertain that changes in the receiving environment are within those predicted. The following questions must be answered:

.1 What testable hypotheses can be derived from the Impact Hypothesis?

.2 What measurements (type, location, frequency, performance requirements) are required to test these hypotheses?

.3 How should the data be managed and interpreted?

8.3 It may usually be assumed that suitable specifications of existing (pre-disposal) conditions in the receiving area are already contained in the application for dumping. If the specification of such conditions is inadequate to permit the formulation of an Impact Hypothesis, the licensing authority will require additional information before any final decision on the permit application is made.

8.4 The permitting authority is encouraged to take account of relevant research information in the design and modification of monitoring programmes. The measurements can be divided into two types - those within the zone of predicted impact and those outside.

8.5 Measurements should be designed to determine whether the zone of impact and the extent of change outside the zone of impact differ from those predicted. The former can be answered by designing a sequence of measurements in space and time that ensures that the projected spatial scale of change is not exceeded. The latter can be answered by the acquisition of measurements that provide information on the extent of change that occurs outside the zone of impact as a result of the dumping operation. Frequently, these measurements will be based on a null hypothesis - that no significant change can be detected.

8.6 The results of monitoring (or other related research) should be reviewed at regular intervals in relation to the objectives and can provide a basis to:

.1 modify or terminate the field-monitoring programme;

.2 modify or revoke the permit;

.3 redefine or close the dump-site; and

.4 modify the basis on which applications to dump wastes are assessed.

9 PERMIT AND PERMIT CONDITIONS

9.1 A decision to issue a permit should only be made if all impact evaluations are completed and the monitoring requirements are determined. The provisions of the permit shall ensure, as far as practicable, that environmental disturbance and detriment are minimized and the benefits maximized. Any permit issued shall contain data and information specifying:

.1 a description of the best environmental practices (see paragraph 5.2) for the disposal option selected whether for a platform that is to be left in place, either standing or toppled in place, or for platforms that will be removed to another dump-site at sea;

.2 the location of the dump-site(s);

.3 the method of dumping; and

.4 a notification of the appropriate national authority of the co-ordinates of the platform/structure on the sea bottom after disposal.

9.2 If dumping is the selected option, then a permit authorizing dumping must be issued in advance. It is recommended that opportunities be provided for public review and participation in the permitting process. In granting a permit, the hypothesized impact occurring within the boundaries of the dump-site, such as alterations to the physical, chemical and biological compartments of the local environment is accepted by the permitting authority.

9.3 Regulators should strive at all times to enforce procedures that will result in environmental changes as far below the limits of allowable environmental change as practicable, taking into account technological capabilities as well as economic, social and political concerns.

9.4 Permits should be reviewed at regular intervals, taking into account the results of monitoring and the objectives of monitoring programmes. Review of monitoring results will indicate whether field programmes need to be continued, revised or terminated, and will contribute to informed decisions regarding the continuance, modification or revocation of permits. This provides an important feedback mechanism for the protection of human health and the marine environment.

Annex 6

Revised specific guidelines for assessment of inert, inorganic geological material

1 INTRODUCTION

1.1 The Guidelines for the Assessment of Wastes or Other Matter that May be Considered for Dumping,[17] referred to in short as the "Generic Guidelines", as well as the Specific Guidelines for the Assessment of Inert, Inorganic Geological Material addressed in this document are intended for use by national authorities responsible for regulating dumping of wastes and embody a mechanism to guide national authorities in evaluating applications for dumping of wastes in a manner consistent with the provisions of the London Convention 1972 (London Convention) or the 1996 Protocol thereto (London Protocol). Annex 2 to the London Protocol places emphasis on progressively reducing the need to use the sea for dumping of wastes. Furthermore, it recognizes that avoidance of pollution demands rigorous controls on the emission and dispersion of contaminating substances and the use of scientifically based procedures for selecting appropriate options for waste disposal. When applying these Guidelines uncertainties in relation to assessments of impacts on the marine environment will need to be considered and a precautionary approach applied in addressing these uncertainties. They should be applied with a view that acceptance of dumping under certain circumstances does not remove the obligation to make further attempts to reduce the necessity for dumping.

1.2 The London Protocol follows an approach under which dumping of wastes or other matter is prohibited except for those materials specifically enumerated in Annex 1, and in the context of that Protocol, these Guidelines would apply to the materials listed in that Annex. The London Convention prohibits the dumping of certain wastes and other matter specified therein and in the context of that Convention these Guidelines meet the requirements of its Annexes for wastes not prohibited for dumping at sea. When applying these Guidelines under the London Convention, they should not be viewed as a tool for the reconsideration of dumping of wastes or other matter in contravention of Annex I to the London Convention.

1.3 The schematic shown in Figure 1 provides a clear indication of the stages in the application of the Guidelines where important decisions should be made and is not designed as a conventional "decision tree". In general, national authorities should use the schematic in an iterative manner ensuring that all steps receive consideration before a decision is made to issue a permit. Figure 1 illustrates the relationship between the operational components of Annex 2 of the London Protocol and contains the following elements:

- .1 Waste Characterization (Chapter 4) (Chemical, Physical and Biological Properties);
- .2 Waste Prevention Audit and Waste Management Options (Chapters 2 and 3);
- .3 Action List (Chapter 5);
- .4 Identify and Characterize Dump-site (Chapter 6) (Dump-site Selection);
- .5 Determine Potential Impacts and Prepare Impact Hypothesis(es) (Chapter 7) (Assessment of Potential Effects);

[17] The first version of these Guidelines was adopted in 1997 and their revision was completed [by the governing bodies under the London Convention and Protocol in 2008].

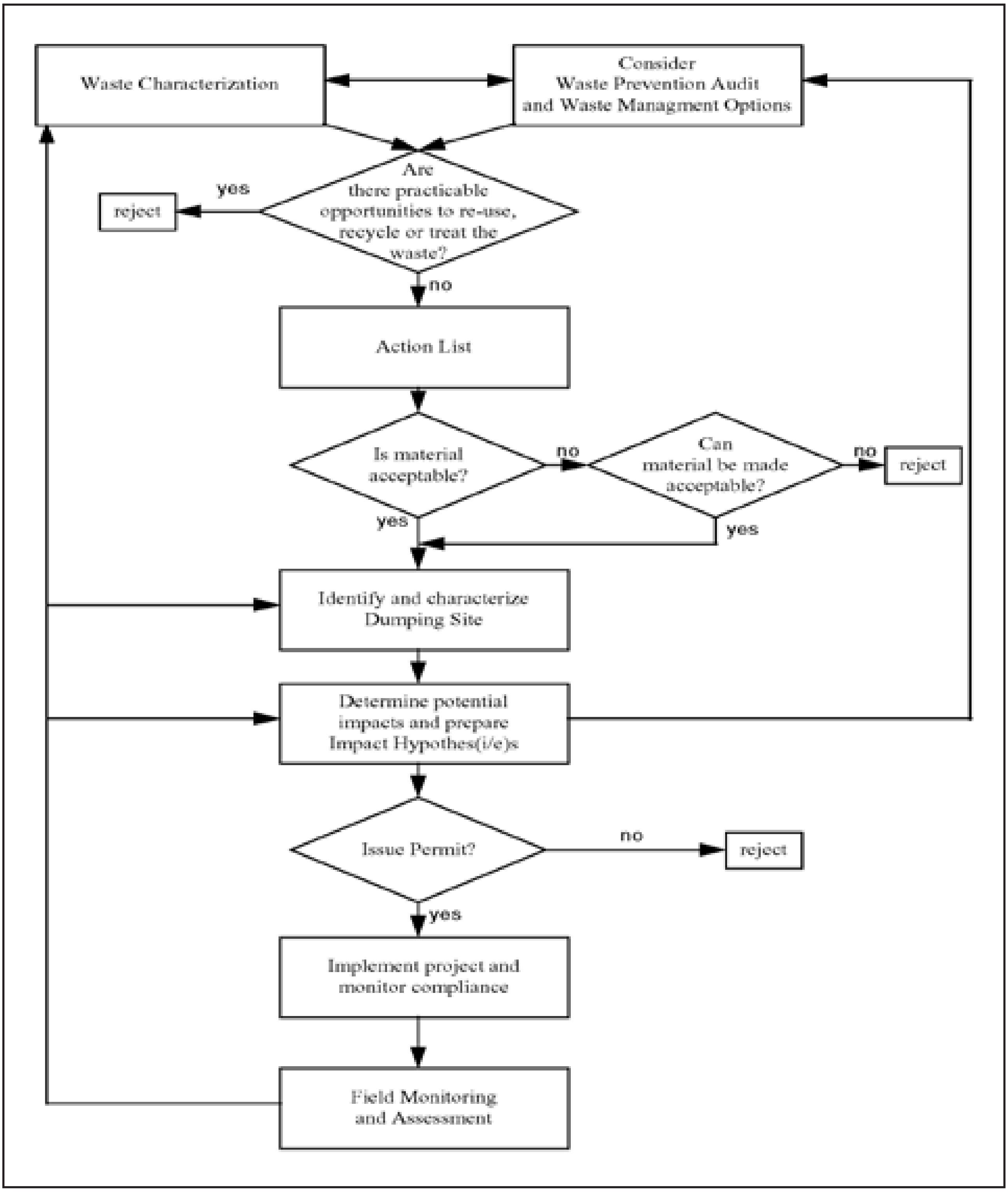
Waste Characterization
Consider
Waste Prevention Audit
and Waste Managment Options
Are
there practicable
opportunities to re-use,
recycle or treat the
waste?
yes
reject
no
Action List
Is material
acceptable?
no
Can
material be made
acceptable?
no
reject
yes
yes
Identify and characterize
Dumping Site
Determine potential
impacts and prepare
Impact Hypothes(i/e)s
Issue Permit?
no
reject
yes
Implement project and
monitor compliance
Field Monitoring
and Assessment

Fig. 1

.6 Issue Permit (Chapter 9) (Permit and Permit Conditions);

.7 Implement Project and Monitor Compliance (Chapter 8) (Monitoring); and

.8 Field Monitoring and Assessment (Chapter 8) (Monitoring).

1.4 These Guidelines are specific to inert, inorganic geological material,[18] i.e., wastes or other matter which have been determined, through an initial qualitative characterization, to have met the Eligibility Criteria for Inert, Inorganic Geological Material (appendix). Adherence to the following represents neither a more restrictive nor a less restrictive regime than that of the Generic Guidelines of 1997.

2 WASTE PREVENTION AUDIT

2.1 The initial stages in assessing alternatives to dumping should, as appropriate, include an evaluation of:

.1 types, amounts and relative hazards of wastes generated. As the material is inert, the relative hazards are confined to those resulting from the physical properties of the material;

.2 details of the production process and the sources of wastes within that process; and

.3 feasibility of the following waste reduction/prevention techniques:

   .1 clean production technologies;

   .2 process modification;

   .3 input substitution; and

   .4 on-site, closed-loop recycling.

2.2 In general terms, if the required audit reveals that opportunities exist for waste prevention at source, an applicant is expected to formulate and implement a waste prevention strategy in collaboration with relevant local and national agencies which includes specific waste reduction targets and provision for further waste prevention audits to ensure that these targets are being met. Permit issuance or renewal decisions shall assure compliance with any resulting waste reduction and prevention requirements.

2.3 For this category of material the most pertinent issue will be waste minimization.

3 CONSIDERATION OF WASTE MANAGEMENT OPTIONS

3.1 Applications to dump wastes or other matter shall demonstrate that appropriate consideration has been given to the following hierarchy of waste management options, which implies an order of increasing environmental impact:

.1 re-use, such as refilling of mines;

.2 recycling such as road construction and building materials; and

.3 disposal on land, and into water.

3.2 A permit to dump wastes or other matter shall be refused if the permitting authority determines that appropriate opportunities exist to re-use, recycle or treat the waste without undue risks to human health or the environment or disproportionate costs. The practical availability of other means of disposal should be considered in the light of a comparative risk assessment involving both dumping and the alternatives.

[18] The Twenty-second Consultative Meeting of Contracting Parties to the London Convention 1972 adopted these specific Guidelines in 2000.

4 CHEMICAL, PHYSICAL AND BIOLOGICAL PROPERTIES

4.1 The character and form of the material and the basis on which it is characterized as geological and inert in the marine environment should be specified. From this specification, it should be demonstrated that the chemical nature of the material (including uptake of any elements or substances from the material by biota) is such that the only effects will be due to its physical properties. Thus, the assessment of the environmental impacts will be based solely upon origin, mineralogy, and the total amount and physical nature of the material.

4.2 Characterization of the material and its constituents shall take into account:

.1 origin, including mineralogy, total amount, and the form in which it is intended to be dumped; and

.2 physical persistence.

5 ACTION LIST

5.1 The Action List provides a screening mechanism for determining whether a material is considered acceptable for dumping. It constitutes a crucial part of Annex 2 to the London Protocol and the Scientific Groups will continuously review all aspects of it to assist Contracting Parties with its application. It may also be used in meeting the requirements of Annexes I and II to the London Convention. As inert materials should not interact with biological systems other than through physical processes, Action List considerations generally do not require detailed consideration for this waste category. However, the Action List screening mechanism should be used to demonstrate that the material is inert and uncontaminated.

6 DUMP-SITE SELECTION

Site selection considerations

6.1 Proper selection of a dump-site at sea for the reception of waste is of paramount importance.

6.2 Information required to select a dump-site shall include:

.1 physical, chemical and biological characteristics of the water-column and the seabed;

.2 location of amenities, values and other uses of the sea in the area under consideration;

.3 assessment of the constituent fluxes associated with dumping, particularly in relation to existing sediment fluxes; and

.4 economic and operational feasibility.

6.3 Guidance for procedures to be followed in dump-site selection can be found in a report of the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP Reports and Studies No.16 – Scientific Criteria for the Selection of Waste Disposal Sites at Sea), as well as in the WAG tutorial set. Prior to selecting a dump-site, it is essential that data be available on the oceanographic characteristics of the general area in which the site is to be located. Relevant information may include the physical, chemical and biological nature of the seabed and the water column. This information can be obtained from the literature but fieldwork should be undertaken to fill the gaps. In terms of chemical and biological characteristics, only those aspects likely to be sensitive to physical effects such as smothering or to changes in turbidity, particle size distributions or sediment transport require detailed consideration.

6.4 Some of the important amenities, biological features and uses of the sea to be considered in determining the specific location of the dump-site are:

.1 the shoreline and bathing beaches;

.2 areas of beauty or significant cultural or historical importance;

.3 areas of special scientific or biological importance, such as sanctuaries;

.4 fishing areas;

.5 spawning, nursery and recruitment areas;

.6 migration routes;

.7 seasonal and critical habitats;

.8 shipping lanes;

.9 military exclusion zones;

.10 engineering uses of the seafloor, including mining, undersea cables, desalination or energy conversion sites.

Size of the dump-site

6.5 Size of the dump-site is an important consideration for the following reasons:

.1 it should be large enough, unless it is an approved dispersion site, to have the bulk of the material remain either within the site limits or within a predicted area of impact after dumping;

.2 it should be large enough to accommodate anticipated volumes of solid waste and/or liquid wastes to be diluted to near background levels before or upon reaching site boundaries;

.3 it should be large enough in relation to anticipated volumes for dumping so that it would serve its function for many years; and

.4 it should not be so large that monitoring would require undue expenditure of time and money.

Site capacity

6.6 In order to assess the capacity of a site, especially for solid wastes, the following should be taken into consideration:

.1 the anticipated loading rates per day, week, month or year;

.2 whether or not it is a dispersive site; and

.3 the allowable reduction in water depth over the site because of mounding of material.

Evaluation of potential impacts

6.7 Due consideration needs to be given to the relative magnitude of the substance fluxes associated with dumping in the local and regional area surrounding the dump-site. In cases where it is predicted that dumping will substantially augment existing fluxes associated with natural processes, dumping at the site under consideration should be deemed inadvisable. The only fluxes that are relevant to inert, inorganic geological material are sediment transport fluxes in the water column and at the sediment-water interface. Particular attention needs to be paid to the degree to which deposition of material may result in effects on marine benthos (e.g., smothering, changes in benthos diversity, habitat modification).

6.8 Temporal characteristics should be considered to identify potentially critical times of the year (e.g., for marine life) when dumping should not take place. This consideration leaves periods when it is expected that dumping operations will have less impact than at other times. If these restrictions become too burdensome and costly, there should be some opportunity for compromise in which priorities may have to be established concerning species to be left wholly undisturbed. Examples of such biological considerations are:

.1 periods when marine organisms are migrating from one part of the ecosystem to another (e.g., from an estuary to open sea or vice versa) and growing and breeding periods;

.2 periods when marine organisms are hibernating on or are buried in the sediments; and

.3 periods when particularly sensitive and possibly endangered species are exposed.

The primary considerations relevant to these provisions are the physical effects of inert, inorganic geological materials on biota in the water column and benthos, including those which arise as a result of habitat modification.

Contaminant mobility

6.9 Contaminant mobility is dependent upon several factors, among which are:

.1 type of matrix;

.2 form of contaminant;

.3 physical state of the system, e.g., temperature, water flow, suspended matter; and

.4 biological activities, e.g., bioturbation.

These issues should not be relevant for an inert, inorganic geological material that passes the Eligibility Criteria and for the reasons given in paragraphs 4.1 and 5.1 above.

7 ASSESSMENT OF POTENTIAL EFFECTS

7.1 Assessment of potential effects should lead to a concise statement of the expected consequences of the sea or land disposal options, i.e., the "Impact Hypothesis". It provides a basis for deciding whether to approve or reject the proposed disposal option and for defining environmental monitoring requirements. As far as possible, waste management options causing dispersion and dilution of contaminants in the environment should be avoided and preference given to techniques that prevent the input of the contaminants to the environment.

7.2 The assessment for dumping should integrate information on waste characteristics, conditions at the proposed dump-site(s), fluxes and proposed disposal techniques and specify the potential effects on human health, living resources, amenities and other legitimate uses of the sea. It should define the nature, temporal and spatial scales and duration of expected impacts based on reasonably conservative assumptions.

7.3 The assessment should be as comprehensive as possible. The primary potential impacts should be identified during the dump-site selection process. These are considered to pose the most serious threats to human health and the environment. Alterations to the physical environment are the primary concern for inert, inorganic geological material, and thus impacts on habitats and human health, the devaluation of marine resources and interference with other legitimate uses of the sea are likely to be seen as the main concerns.

7.4 In constructing an impact hypothesis, particular attention should be given to, but not limited to, potential impacts on amenities (e.g., presence of floatables), sensitive areas (e.g., spawning, nursery or feeding areas), habitat (e.g., biological, chemical and physical modification), migratory patterns and marketability of resources. Consideration should also be given to potential impacts on other uses of the sea including: fishing, navigation, engineering uses, areas of special concern and value, and traditional uses of the sea.

7.5 Even the least complex and most innocuous wastes may have a variety of physical, chemical and biological effects. Impact hypotheses cannot attempt to reflect them all. It must be recognized that even the most comprehensive impact hypotheses may not address all possible scenarios such as unanticipated impacts. It is therefore imperative that the monitoring programme be linked directly to the hypotheses and serve as a feedback mechanism to verify the predictions and review the adequacy of management measures applied to the dumping operation and at the dump-site. It is important to identify the sources and consequences of uncertainty. The only effects requiring detailed consideration in this context are physical impacts on habitats and marine resources and interference with other legitimate uses of the sea.

7.6 The expected consequences of dumping should be described in terms of affected habitats, processes, species, communities and uses. The precise nature of the predicted effect (e.g., change, response or interference) should be described. The effect should be quantified in sufficient detail so that there would be no doubt as to the variables to be measured during field monitoring. In the latter context, it would be essential to determine "where" and "when" the impacts can be expected.

7.7 Emphasis should be placed on biological effects and habitat modification, as well as physical and chemical changes, including:

.1 physical changes and physical effects on biota; and

.2 effects on sediment transport.

7.8 In the case of repeated or multiple dumping operations, impact hypotheses should take into account the cumulative effects of such operations. It will also be important to consider the possible interactions with other waste dumping practices in the area, both existing or planned.

7.9 An analysis of each disposal option should be considered in light of a comparative assessment of the following concerns: human health risks, environmental costs, hazards (including accidents), economics and exclusion of future uses. If this assessment reveals that adequate information is not available to determine the likely effects of the proposed disposal option, including potential long-term harmful consequences, then this option should not be considered further. In addition, if the interpretation of the comparative assessment shows the dumping option to be less preferable, a permit for dumping should not be given.

7.10 Each assessment should conclude with a statement supporting a decision to issue or refuse a permit for dumping.

7.11 Where monitoring is required, the effects and parameters described in the hypotheses should help to guide field and analytical work so that relevant information can be obtained in the most efficient and cost-effective manner.

8 MONITORING

8.1 Monitoring is used to verify that permit conditions are met – compliance monitoring – and that the assumptions made during the permit review and site selection process were correct and sufficient to protect the environment and human health – field monitoring. It is essential that such monitoring programmes have clearly defined objectives.

8.2 The Impact Hypothesis forms the basis for defining field monitoring. The measurement programme should be designed to ascertain that changes in the receiving environment are within those predicted. The following questions must be answered:

.1 What testable hypotheses can be derived from the Impact Hypothesis?

.2 What measurements (type, location, frequency, performance requirements) are required to test these hypotheses?

.3 How should the data be managed and interpreted?

8.3 It may usually be assumed that suitable specifications of existing (pre-disposal) conditions in the receiving area are already contained in the application for dumping. If the specification of such conditions is inadequate to permit the formulation of an Impact Hypothesis, the licensing authority will require additional information before any final decision on the permit application is made.

8.4 The permitting authority is encouraged to take account of relevant research information in the design and modification of monitoring programmes. The measurements can be divided into two types - those within the zone of predicted impact and those outside.

8.5 Measurements should be designed to determine whether the zone of impact and the extent of change outside the zone of impact differ from those predicted. The former can be answered by designing a sequence of measurements in space and time that ensures that the projected spatial scale of change is not exceeded. The latter can be answered by the acquisition of measurements that provide information on the extent of change that occurs outside the zone of impact as a result of the dumping operation. Frequently, these measurements will be based on a null hypothesis – that no significant change can be detected.

8.6 The results of monitoring (or other related research) should be reviewed at regular intervals in relation to the objectives and can provide a basis to:

.1 modify or terminate the field-monitoring programme;

.2 modify or revoke the permit;

.3 redefine or close the dump-site; and

.4 modify the basis on which applications to dump wastes are assessed.

9 PERMIT AND PERMIT CONDITIONS

9.1 A decision to issue a permit should only be made if all impact evaluations are completed and the monitoring requirements are determined. The provisions of the permit shall ensure, as far as practicable, that environmental disturbance and detriment are minimized and the benefits maximized. Any permit issued shall contain data and information specifying:

.1 the types, amounts and sources of materials to be dumped;

.2 the location of the dump-site(s);

.3 the method of dumping; and

.4 monitoring and reporting requirements.

9.2 If dumping is the selected option, then a permit authorizing dumping must be issued in advance. It is recommended that opportunities are provided for public review and participation in the permitting process. In granting a permit, the hypothesized impact occurring within the boundaries of the dump-site, such as alterations to the physical, chemical and biological compartments of the local environment is accepted by the permitting authority.

9.3 Regulators should strive at all times to enforce procedures that will result in environmental changes as far below the limits of allowable environmental change as practicable, taking into account technological capabilities as well as economic, social and political concerns.

9.4 Permits should be reviewed at regular intervals, taking into account the results of monitoring and the objectives of monitoring programmes. Review of monitoring results will indicate whether field programmes need to be continued, revised or terminated, and will contribute to informed decisions regarding the continuance, modification or revocation of permits. This provides an important feedback mechanism for the protection of human health and the marine environment.

APPENDIX

ELIGIBILITY CRITERIA FOR INERT, INORGANIC GEOLOGICAL MATERIAL

BACKGROUND AND PURPOSE

1 The London Convention 1972 (LC), as amended in 1993, prohibits the dumping of industrial waste after 1 January 1996. It further provides in Annex I that the term "industrial waste means waste materials generated by manufacturing or processing operations and does not apply to", among other things, "uncontaminated inert geological materials the chemical constituents of which are unlikely to be released into the marine environment".

2 The 1996 Protocol to the London Convention 1972 (LP) follows an approach under which the dumping of all wastes or other matter is prohibited except for those materials specifically enumerated in Annex 1 to the 1996 Protocol. The Protocol states that "the following wastes or other matter are those that may be considered for dumping being mindful of the objectives and general obligations set out in Articles 2 and 3", including, "inert, inorganic geological material".

3 Both LC and LP prohibit dumping of waste with more than *de minimis* radioactivity. Separate guidance on how to make that determination can be found in the "Guidelines for the Application of the *De Minimis* Concept under the London Convention 1972" and will not be further addressed in this document.

4 This document provides guidance for determining whether candidate materials can initially be considered as inert, inorganic geological material eligible for further consideration for dumping under LC or LP. If the proposed materials are found eligible for consideration under this category, this does not mean they should necessarily receive a permit for dumping at sea. The decision on whether to issue such a permit can only be made after carefully taking into account the "Specific Guidelines for Assessment of Inert, Inorganic Geological Material" (IIGM Guidelines). The IIGM Guidelines are used to evaluate applications for dumping of eligible waste under LC or LP, and include waste prevention audits, consideration of alternatives to dumping, characterization of the potential dump site, rigorous assessment for potential impacts, and monitoring.

5 The wording regarding geological materials differs slightly between LC and LP[19]. This document provides narrative criteria for use in determining whether material is:

> "uncontaminated inert geological materials the chemical constituents of which are unlikely to be released into the marine environment" (LC – terminology); and
>
> "inert, inorganic geological material" (LP – terminology).

6 If, after considering these criteria, the material is deemed to fall outside the scope of the relevant category, it is either (1) ineligible for consideration for dumping or (2) may constitute a different category of waste or other matter eligible for consideration under other material-specific guidance.[20]

7 In order to apply this guidance, it will be necessary to perform an initial qualitative characterization of the waste or other matter to be considered for dumping.

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[19]For example, the IIGM Guidelines apply to LC and designed to apply to LP upon entry into force.

[20]Other guidance documents address the other types of material eligible for consideration for dumping (i.e., dredged material, sewage sludge, fish waste, vessels and platforms, organic material of natural origin, certain bulky items).

8 The applicable criteria in the following guidance will need to be satisfied if the material can initially be considered as "uncontaminated inert geological material" (LC) or "inert, inorganic geological material" (LP).

GUIDANCE

STEP 1: TYPE OF MATERIAL – "GEOLOGICAL"

Discussion

9 Both under LC and LP proposed materials must be geological in nature. To be a geological material it should only comprise materials from the solid portion of the Earth such as rock or mineral. In addition, the geological material should not be altered from its original state by physical or chemical processing in a way that would result in different or additional impacts to the marine environment compared with those expected from the unaltered material.

Decision Criteria

10 Questions to determine whether the candidate material is geological:

.1 does the candidate material only comprise materials from the solid mineral portion of the Earth; and

.2 has the material been altered from its original state by physical or chemical processing in a way that would result in different or additional impacts to the marine environment compared with those expected from the unaltered material?

11 If the answer to 10.1 above is **YES** and the answer to 10.2 is **NO**, the material is geological in nature.

12 If the answer to 10.1 is **NO** or the answer to 10.2 is **YES**, the material is not geological and cannot be considered for dumping as IIGM.

STEP 2: TYPE OF MATERIAL – "INERT"

Discussion

13 Under both LC and LP the geologic material must be "inert" in order to be considered for dumping.[21] In order to be inert, the candidate material and its constituents must be essentially of a chemically non-reactive nature and the chemical constituents of the material are unlikely to be released into the marine environment. The primary issue in determining whether a material is inert for the purposes of the Convention is to ensure that the only impacts of concern following dumping are restricted to physical effects.[22] In making such a determination, consideration must be given not only to pre-disposal characteristics of the material but also to whether it may undergo significant physical, chemical, or biological transformations when deposited in a marine system.

14 Key factors in determining if a proposed material is inert are knowledge of the material's constituents, including any potential contaminants, and what, if any, reactions might occur following the material's exposure to physical, chemical, or biological processes in the marine environment. Material that may result in acute or chronic toxicity, or in bioaccumulation of any of its constituents, should not be considered inert.

[21]Under LC it is also specified that its chemical constituents must be unlikely to be released into the marine environment. A determination that the material is "inert" undertaken in accordance with this guidance document will also satisfy that aspect of LC.

[22]In paragraph 5.1 of the IIGM Guidelines eligible materials are described as those "inert materials [that] will not interact with biological systems other than through physical processes."

Decision Criteria

15 Considering both the pre-disposal nature of the material and any alterations to it that may result from physical, chemical, or biological processes in the sea, are the only effects of concern those resulting from the physical properties of the material?

16 If the answer to the above is **YES**, the material is inert.

17 If the answer is **NO**, the material is not inert and may not be considered for dumping as IIGM.

STEP 3: TYPE OF MATERIAL – "INORGANIC" (LP only)[23]

Discussion

18 Under LP, candidate geologic materials must be inorganic materials. These materials are usually of mineral origin. Materials such as sand, salt, iron, calcium salts and other mineral materials are examples. If a material does not contain more than incidental and trivial amounts of compounds with carbon chemically bound to hydrogen, it is also considered inorganic.

Decision Criteria

19 Inorganic materials are usually of mineral origin. Other materials may be deemed inorganic if they contain only incidental and trivial amounts of compounds with carbon chemically bound to hydrogen. Questions to determine whether candidate geological materials are inorganic:

.1 are the materials of inorganic mineral origin; and

.2 does the material contain no more than incidental and trivial amounts of compounds with carbon chemically bound to hydrogen?

20 If the answer to both (1) and (2) is **YES**, the material is inorganic.

21 If the answer to either (1) or (2) is **NO**, it is not inorganic and cannot be considered for dumping as IIGM.

STEP 4: TYPE OF MATERIAL – "UNCONTAMINATED" (LC only)[24]

Discussion

22 As stated in Annex I of LC, candidate geological material must be uncontaminated.

23 Contaminants are constituents that are potentially harmful to the marine environment and are:

.1 introduced to the material through anthropogenic activities; or

.2 concentrated in the material to a magnitude greater than naturally found in geologically similar material.

24 Material exposed only to ambient, widely dispersed, contamination (e.g. typically through atmospheric deposition or precipitation) should not be deemed "contaminated".

Decision Criteria

25 Questions to determine whether candidate geological materials are uncontaminated:

.1 have contaminants been introduced at the material's source? (e.g., has the material been exposed to spills or other sources of contamination or subject to inadequate pollution controls); and

[23]The term "inorganic" is used in LP, but not in LC. As a result, this criterion is only relevant in the LP context.

[24]The term "uncontaminated" is only used under LC. As a result, this criterion is only relevant in the LC context.

.2 have contaminants been introduced or concentrated beyond a magnitude greater than naturally found in geologically similar material during any subsequent processing or modification of the material?

26 If the answer to both of the above questions is **NO**, the material can be considered uncontaminated.

27 If the answer to either of the questions above is **YES**, the material is contaminated and, therefore, may not be considered for dumping as uncontaminated IIGM unless it can be verified that all necessary steps have been taken to remove the contaminants.

Annex 7

Monitoring

Permits issued for artificial reef projects should include a requirement for monitoring programmes, which should have the following objectives:

i) to ensure that the reef is constructed and operated according to the conditions specified in the permit i.e. **compliance monitoring**;

ii) to assess to what extent the reef is meeting the stated purpose for which it was constructed. i.e. were the design, materials, location etc. suitable for the intended function. This is generally termed **efficacy monitoring**;

iii) verification of the positive and negative **environmental impacts** of the reef.

Monitoring should start with the placement of the reef and then be maintained throughout its life, or at least until the authorities are satisfied that it is no longer necessary. The results of this monitoring will provide a basis for decisions regarding possible alterations to the structure or, in extreme cases, removal thereof. Where placements require long periods of time (years) to be completed, monitoring should be initiated in parallel to the construction so that any necessary modifications to the reef can be made even prior to completion.

This Annex provides guidance on monitoring activities to assess the efficacy of the reef in relation to its objectives, as well as on environmental monitoring.

1 Efficacy monitoring – is the reef working?

Assessment of the efficacy of a reef includes two different aspects: i) an assessment of the reef's stability or structural integrity; and ii) an assessment of its functionality.

The functionality of a reef must be assessed against indicators linked to the original objectives of the reef. They must be established prior to its construction, and should be quantifiable. For example, the success of a fisheries enhancement reef can be measured against the number of fish caught in the area. Similarly, a diving reef can be assessed on the basis of the number of visitors hiring SCUBA gear, or a protection reef by an increase or reduction in the number of trawling boats that fish using illegal practices, etc.

1.1 Monitoring the reef's stability (movement, sinking and structural integrity)

Surveys using, for example, lateral scanning sonar, should be conducted at regular intervals to determine the position of the reef and its height above the sea bed. Its structural integrity can be assessed by visual diving inspections or using remote submarine filming (with an ROV). The recommended frequency for these tasks is once a year during at least the first five years after the reef was placed, and every two or three years thereafter.

1.2 Monitoring the functionality of the reef

Potential indicators and the recommended methodology for the various types of reef are outlined below:

Anti-trawling (protection) artificial reefs

The purpose of these reefs is the protection of fishing resources from specific fishing activities, usually trawling.

Indicators:

- A reduction in the number of vessels that employ illegal trawling techniques by an agreed percentage. However, it is difficult to monitor these activities since they require more or less continuous sampling to obtain a good measure of the activity.
- An alternative is a reduction in the number of trawling marks in the area.

Method:

Obtaining an estimate of the number of vessels engaged in illegal trawling requires on-site sampling over representative periods and at the times when the restricted fishing fleets are supposed to be working.

Trawl marks can be picked up using geophysical techniques, including side-scan sonar.

In both cases, the level of efficacy is determined by comparing the values of the relevant variable before and after deployment of the reef.

Fishery enhancement artificial reefs

These reefs can serve a variety of purposes including:

- The attraction or concentration of particular target species (usually fish) by providing shelter and food
- The provision of substrate for the cultivation of algae or molluscs.
- Promotion of an increase in the fishing productivity in the adjacent environment.
- Improving the quality of the environment with an associated increase in its productivity.
- The development of communities which occupy hard rather than soft or sedimentary substrates.

Indicators:

- The diversity, biomass, or percentage coverage of species on the reef (as a measure of increased productivity).
- The number and size of individuals belonging to the species that reef wishes to attract or concentrate.
- The percentage increase in catch by the fishing fleet in the area.

Method:

Quantifying the presence of the target species should be done through an on-site census of these species, recording the number and size of individuals.

Monitoring of diversity and the spatial structure of populations on the reef must obviously include not only the target species, but also the associated organisms. These variables can be measured by direct sampling of the benthic biota, followed by identification and quantification. Alternative methods include photographic monitoring, which is non-destructive, or the installation of removable panels.

Changes in the catch of the fishing fleet should be measured by comparing pre- and post-deployment average annual catch data for the species concerned.

Artificial reefs used to rehabilitate degraded ecosystems

The purpose of these reefs is to improve the quality of degraded habitats or ecosystems, by acting as a base for the settlement of the impacted species e.g. coral communities.

Indicators:

- The level of coverage of the reef by the main species after a set period of time, and in comparison to what was anticipated.

- The percentage increase in diversity, biomass, coverage etc of the biological community as a whole, after a set period of time.

Method:

On-site underwater sampling using divers is recommended to check the flora or fauna present on the reef. Coverage can be measured with various imaging techniques or quadrat surveys, and must include a sufficient number of samples to obtain a representative indication of the population across the total surface area of the reef.

Biomass and diversity can be measured by direct sampling of the benthic biota, followed by identification and quantification. Alternative methods include photographic monitoring, which is non-destructive, or the installation of removable panels.

Artificial reefs for recreational or research activities

The purpose of these reefs is to promote recreational (e.g. SCUBA diving) or scientific activities.

Indicators:

- The indicators will depend on the type of activity but, in general, they will be based on establishing the number of visits to the reef over a specific period of time.

Method:

The precise quantification of the number of visits to a reef is complicated, as some of these visits will be undertaken by individuals not associated with the organisation which is managing the reef. For example, in some cases, the access to wrecks by SCUBA divers may be controlled by local clubs. Therefore, such assessments are likely to provide only an approximate estimate of the increase in the activity.

Records from diving clubs can be complemented by carrying out individual surveys.

2 Environmental Monitoring

The aims of an environmental monitoring program should be to assess the environmental impacts of the reef and/or conflicts between the artificial reef and other legitimate uses of the sea or parts of it. The monitoring should also aim to determine:

- whether the area impacted differs from what was predicted in the environmental evaluation; and
- whether the scope of changes beyond the predicted area of impact differs from those foreseen.

Where an artificial reef appears not to be meeting its objectives, the monitoring may also cover variables which were used in the original design of the reef, and which may be the cause of its instability and/or lack of functionality.

Monitoring programmes should be subject to quality control covering monitoring criteria, sampling methods, site selection, frequency of sampling, and report submission procedures. The impacts to be assessed include those on the biotic and abiotic environments, and the aim of measuring each specific variable – physical, chemical or biological – must be clear.

Physical variables to be measured can include currents, sediment characteristics (grain size), water properties (temperature, salinity, density etc) through the entire water column and extended horizontally to the entire region that is likely to be affected by the placement of materials.

Chemical observations will generally be related to the type of material used in constructing the reef, and other possible sources of contamination.

The nature and frequency of biological observations should reflect the scale of the placement operation and the degree of potential risk for the resources. If physical effects on the sea bed are expected, it may be necessary to carry out an assessment of the biomass and productivity of the phytoplankton and zooplankton before the placement in order to get an overview of the area. Monitoring of the benthic and epibenthic fauna and flora is likely to be most informative given that they are directly subject to the influence of the water column and to changes (including leaching) in the reef materials.

Concise reports on monitoring activities should be made available to interested parties on a regular basis, with the frequency depending on the scale of the placement operation. The results should be reviewed at regular intervals with a view to, as necessary:

- modifying or concluding the monitoring programme;
- modifying or revoking the placement permit;
- redefining or confirming the placement site; and
- modifying the basis to assess the placement permit.

Annex 8

Dismantling

When monitoring studies indicate that an artificial reef is not functioning as was intended – or not to the extent intended - or that there are negative impacts that were not identified in the environmental impact evaluation, there are two options which should be investigated: i) the reef should be modified so as to rectify the situation; or ii) if modification is not possible, or has failed, the competent authority may take a decision, in the public interest, to have the reef structure dismantled and removed. In such cases, the dismantling and removal of the structures may entail a series of difficulties similar to those involving their placement.

The dismantling process will be more or less complex, depending on the bathymetric characteristics of the sea bed, the depth at which the structures are located and the type of reef. It will require the planning of a series of activities covering the disassembly, lifting on board and transport of the structure to the nearest port. These include establishing the exact current location of the modules or anchored structures - as well as their current state i.e. are they still intact or not - and the extraction methodology. Moreover, provision must be made to ensure that there is no interference with navigation in the area and that the environmental quality of the ecosystem is not further altered.

Although the dismantling of reefs would usually follow a process similar to that used to place them, a prior study of the main parameters likely to be affected during the extraction process may be required depending on the local conditions. These may include:

- A study of the current state of the reef and the sea bed (depending on the period of time that has passed and the dynamics of the sea bed, the blocks that might have been offset, moved, buried, fractured, etc.), using a geo-reference process. This must assess the weight, number, size and shape of the structure/s to be removed; the nature of the seabed at the site; tidal currents and wind or wave action;
- An assessment of the resources and systems available for the dismantling: these should include the type of boats capable of transporting the modules; the availability of cranes capable of lifting the blocks; and the technical and human resources required for this process (buoys, signalling markers, auxiliary boats, etc.).
- A study to show how best to optimise economic costs.
- A study on optimisation of transport (system, procedure, methodology and tools) of the reef modules from the pick-up area to the dock, and their subsequent unloading, cleaning, storage and management.
- Proposals for quality control of the dismantling operation.
- Proposals for restoration and regeneration of ecosystems that could have been damaged during the life of the reef.

Where a dismantling procedure was defined prior to placement, this may need to be adjusted depending on whether i) conditions have changed at the site; ii) the reef has moved; or the initial study is considered to have been inaccurate.

While the details of dismantling will vary from reef to reef, in general, for purpose-built reefs, the steps include:

- Separation of the blocks or modules
- Lifting of individual blocks one at a time onto the vessel using a crane;

- Securing of the blocks onto the deck of the vessel and according to an agreed plan to maintain the stability of the vessel;
- Transport to the port;
- Unloading and transfer to storage
- Depending on the nature of the modules, recycling or re-use.

Where vessels, docks, marine platforms and other structures which normally degrade with time, are used to create an artificial reef, it should be borne in mind that this is likely to be permanent, as it is extremely difficult to remove them later. When such structures have to be removed, specialised vessels and equipment is required to ensure that they do not collapse while being lifted from the seabed. Such operations should only be attempted when absolutely necessary.

ISBN: 978-92-807-3022-7
May 2009 DEP/1167/CA
IMO reference: N114E