ARTIFICIAL REEFS, SCOTLAND

Benefits, costs and risks

REPORT

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Executive Summary

An artificial reef comprising some 42,000 tonnes of mineral block is being deployed in Loch Linnhe off the west Coast of Scotland, with construction spread over the period 2001-2004. Intended as a major ***in situ*** laboratory, a programme of integrated research has already commenced to explore the wide range of physical, biological, social and economic impacts of this development. Over time the results will inform all concerned as to the economic potential that such physical structures might offer peripheral communities in the Scottish Highlands and Islands.

This report is focused on exploring and interpreting the experiences of artificial reef deployment throughout the world. In particular, the exercise is intended to identify the range of potential benefits and liabilities that might accrue to any local community looking to lay down such a reef, and to examine where lessons can be learnt from elsewhere in respect of ownership, management and cost recovery.

Benefits

The OSPAR[1] guidelines on artificial reefs suggest the following purposes of artificial reefs:

- reduction of flooding and coastal erosion;
- providing sheltered anchorages for shipping and small boats;
- development of habitat for crustaceans fisheries (e.g. lobsters), particularly in conjunction with juvenile restocking;
- providing substrate for algae or mollusc cultivation;
- providing means of restricting fishing in areas where stocks are in need of protection;
- creating fish aggregation areas for fisheries, sport anglers and diving;
- replacing habitats in areas where particular substrates are under threat;
- mitigation for habitat loss elsewhere (e.g. consequence of land reclamation);
- production of marine resources.

Additionally, some reef developers cite the potential to safely utilise waste materials that would otherwise have to be disposed of. This cannot however be a primary reason for a material's use.

A single artificial reef may be installed to provide a number of benefits; this will increasingly be so as the costs must be weighed up against the perceived benefits. It is anticipated that in the short term, of most interest to Scottish coastal communities initially are reefs designed to:

- afford coastal protection and safe anchorage;
- enhance shellfish fisheries and contribute to the control of fishing effort; and

[1] The Convention for the Protection of the Marine Environment of the North-East Atlantic ("OSPAR Convention") was opened for signature at the Ministerial Meeting of the Oslo and Paris Commissions in Paris on 22 September 1992.

- aid aquaculture waste management for cages and diversification into shellfish culture.

Liabilities

Improper artificial reef placement can potentially injure persons, property, and natural resources. Risks include:

- injuries to personnel handling reef materials;
- damage to vessels transporting reef materials;
- improper location causing damage to fishing gear;
- damage to vessels in transit over the reef;
- damage to buried pipelines and cables;
- injury to recreational divers;
- decomposition or movement of the reef material to an unauthorized location;
- environmental hazards caused by incomplete cleaning of used materials;
- damages to existing natural resources, such as crushing live coral reefs;
- costs involved with total removal if instructed.

The owner of a reef needs to be specified in order to address such potential liabilities. In the case of the Loch Linnhe reef, as is expected with future reefs, the owner is the licensee.

The type of liability changes from the construction / deployment phase to the post-deployment phase. Initially the scope of liability will be the same as for any marine engineering project.

SAMS has taken out liability insurance that increases as the amount of material deployed increases, and covers the possible future need for the complete removal of the reef. The premiums amount to £1,000 to £3,000 per year for the Loch Linnhe reef.

Liabilities are minimal if license conditions are met. Of primary importance is the notification to the competent authorities of the reef's precise position and depth. Once marked on navigational charts, unless the reef moves or changes scale significantly, any subsequent collision is the fault of the vessel operator.

Although yet to be tested in the UK, any accident associated with users of the reef should also hold minimal culpability for the reef owners. In the US, artificial reefs are treated in the same way as public parks. If users are properly notified of the potential risks and dangers public authorities are not held responsible.

As long as the initial objective for the reef does not change, the license will change post-deployment from marine construction to a permanent deposit license so any liability is expected to reduce or disappear. Ownership is unclear when the permanent deposit status is revoked. Some EU states press for removal at any point in the lifecycle and following the end of its usefulness. The UK does not subscribe to this and authorities suggest that any such structure will ultimately take on the status of a natural reef.

Ownership

Ownership of the reef goes through two distinct phases. Whilst the reef is being constructed, either on shore or on the surface at its deployment site, it is very clearly the property of the entity undertaking the construction or the donor of the material being used.

To occupy an area of seabed, for whatever reason, requires permission from the Crown Estate and may incur a rent. It therefore follows that an artificial reef is the property of the licence holder / deployment agency that pays rent to the Crown Estate.

There is a very strong argument for there to be some sort of public ownership through central and local government. This could be done with the Crown gifting the seabed occupied or charging a nil rent.

There is the potential to transfer ownership of the Loch Linnhe reef in the future, perhaps from SAMS to the local community, but this is to be decided in the years ahead.

Management

Existing artificial reef structures are subject to a complex legal regime drawing from numerous fields of law. This reflects a variety of influences, including different national legal systems, the purpose for which reefs are constructed, issues of property rights and measures for mitigating the impact of artificial reefs on other maritime activities and the environment.

There is, however, one key characteristic in common: that while there is a need to manage fishing activities over artificial reefs (even if only to prohibit fishing activities to protect spawning grounds and habitats), only rarely will developers and operators make use of fisheries management tools.

The use of reefs in fisheries management is generally within a suite of management measures. Hong Kong research concluded that no studies unequivocally demonstrate enhancement of fish resources by ARs alone. They found that 'custom -built' modules may be essential for the achievement of effective stock enhancement using Ars. In this case, developers will need to have detailed knowledge of the ecology of the target species, and design and construction is likely to be expensive.

Marine Fishery Reserves or Marine Protected Areas (MPAs) represent a promising approach to restoring, if not enhancing, reef fishery resources, and it may well make better economic and biological sense to develop a network of appropriately placed MPAs and do away with the expense and uncertainty of ARs.

Artificial reefs in Japan are considered to be publicly owned and not private capital. They are infrastructures placed at the disposal of the users who are fishermen, comparable with any other professional infrastructure. Nonetheless, most artificial reefs in Japan are established for the explicit benefit of fishermen through resource harvesting, and are managed by the beneficiary fishermen through Fisheries Management Organisations applying the principles of Community Based Fisheries Management within the true system of TURF (Territorial User Rights Fisheries).

At the time of writing the “Water Environment and Water Services” bill is being put in front of the Scottish Parliament. MSPs are expected to pass the bill, which further devolves planning responsibility to local authorities and requires consultation with the local communities.

Use and access to UK reefs could be controlled by local byelaw, or through the use of Regulating and Several Orders. All require extensive consultation, which is necessary to

avoid the potential conflicts between users, such as fishermen operating different gear types.

The management format most likely to meet different community requirements is probably the coastal forum set-up, which has been established across Scotland since 1994. The forums are partnerships to care for coastal areas: their environment, their people and their visitors.

Under the adopted principles of Integrated Coastal Zone Management (ICZM) coastal communities are in a better position to fully participate in the management of resources, which have an impact on their living conditions and environment. A recent assessment of the local coastal management partnerships concluded that the voluntary partnership has been an effective mechanism to progress ICZM to its current state in Scotland. It is unlikely that any other mechanism could have achieved the stakeholder involvement and strategy planning as effectively as the partnership.

Cost recovery

The issue of cost recovery arises where those using and benefiting from the reef, either directly or indirectly, differ to those funding the reef's creation and management. If reef developers themselves are the primary beneficiaries (aquaculture operations, fishermen, communities) there may be no need for specific cost recovery.

Experiences around the world (primarily with US recreational fishing and diving reefs) show that some form of cost recovery from the perceived beneficiaries of the reef is generally attempted, often to fund the requisite monitoring and management of the reef. Covering the costs of liability insurance would also be a priority for reef managers.

The economic returns from an activity-based reef (sport fishing / diving) appear to be higher than a reef where the income is related to the harvesting of natural resources. Additional costs can, however, be expected in the need to develop reefs dependent upon visitors rather than users from the local community. Marketing effort may be considerable and the supporting infrastructure is necessary to provide a full package to the visitor. The reef development should therefore be supported by a tourism and marketing strategy.

Full cost recovery may, however, prove unfeasible over a time-scale acceptable to most businesses. Certain reefs may be fully functional immediately after deployment, but those dependent upon colonisation may take years to mature. Contrary to most assets, however, rather than depreciating, an artificial reef designed to enhance biological production should increase benefits to users as it matures.

The above issues suggest that for reefs supporting existing coastal industry such as fishing or aquaculture it is simpler if the developers are also the prime beneficiaries, or the local community recognises that such a development is beneficial to the wider community.

If the aim is to introduce new users such as divers or anglers, a more direct fee could be charged, but this will also be minimal if attempting to develop new sectors.

Implications for Scottish coastal communities

Artificial reefs may provide a number of potential benefits to Scottish Coastal communities.

Although there are many designs, scales and situations possible, the costs of ARs can all too easily outweigh the quantifiable benefits. This is particularly true for reefs aimed at supporting communities through enhancing local fisheries. In these instances, critical to a reef's economic feasibility will be:

- additional functions of the reef and resulting benefits;
- cost of reef material (including location and transport from source);

- cost of deployment;
- arrangements for the necessary monitoring and management of the reef.

The funding requirements for these significant subsea structures may lead to artificial reef developers emphasising the more quantifiable and comparative benefits such as those associated with coastal protection, while at the same time pointing to perceived secondary benefits such as fisheries enhancement.

Interest in artificial reefs in Scottish inshore waters is currently most likely to emanate from fishery interests. On current evidence the scale of benefits that might be derived from such use is unlikely in a Scottish context to justify the likely costs of construction and management. This is particularly so when the wealth of productive inshore fishing habitats around the Scottish coast is taken into consideration. Nonetheless, there is much to be learned from the related fishery management systems that have been successfully developed by Japan for the management of both artificial reefs and inshore fishing grounds.

Where recreational / tourism potential is considered of particular merit, then it is perhaps to the US and Australian experiences in ownership, management and crucially cost recovery, than one should turn to for information. In these examples various combinations of user rights, license fees, activity fees, and indirect taxation have been successfully used to cover the costs of reef deployment and subsequent management.

The need for liability insurance, long-term management and monitoring suggests that Scottish coastal communities would need to develop artificial reefs in partnership with local government (liability), statutory authorities (management) and research institutes (monitoring).

Partnerships involving these interest groups already exist in the form of the various Scottish coastal forums. The role of such groups may be enhanced by the introduction of River Basin Advisory Groups as part of the Water Environment and Water Services Bill.

The introduction of the Water Environment and Water Services Bill should encourage potential artificial reef developers and ensure such developments are undertaken with the consensus of local communities.

Case studies should be developed in association with these groups to determine:

- The needs of coastal communities - strategies to assist their sustainable development and identification of the extent to which artificial reefs may contribute.
- Potential for multi-purpose reefs to maximise benefits to coastal communities.
- Availability of suitable material and associated costs and benefits.

If, following the above research, it is expected that a number of artificial reefs will be developed around the Scottish coast, a set of guidelines should be developed to assist potential developers. Licence conditions should also stipulate the contents of required long-term management plans.

1. Introduction

1.1 Background

The European Artificial Reef Research Network (EARRN) defines an artificial reef as a submerged structure deliberately placed on the substratum (seabed) to mimic some characteristics of a natural reef[2].

An artificial reef comprising some 42,000 tonnes of mineral block is to be deployed in Loch Linnhe off the west Coast of Scotland, with construction scheduled over the period 2001-2004. Intended as a major *in situ* laboratory, a programme of integrated research has already commenced to explore the wide range of physical, biological, social and economic impacts of this development. Over time the results will inform all concerned as to the economic potential that such physical structures might offer peripheral communities in the Scottish Highlands and Islands, as well as informing assessments of the environmental repercussions associated with the deployment of such structures.

To date the main focus of research has been twofold. The bulk of research has been in establishing physical and biological baselines for the area in which the reef is now being deployed, as required under EU and local planning guidelines. Foundation work has been undertaken to identify the most suitable structure and composition of the blocks being used to form the reef from a range of physical, biological, chemical and economic perspectives.

It is likely to be some years before the full complement of costs and benefits arising from the deployment of the Loch Linnhe structure become evident, but it is appropriate to explore at this early stage some of the more socio-economic, economic and commercial dimensions of such developments. This report is focused on exploring and interpreting the experiences of artificial reef deployment in other parts of the world in the context of the Scottish Highlands and Islands. In particular the implications of artificial reefs for Scottish coastal communities will be considered.

1.2 Scope of the study

The centuries-old Japanese practice of 'enhancing the marine environment' with the use of specifically designed man-made material has become a global phenomenon in the past few decades. The US has seen state-sponsored and private reefs being created mainly to enhance sport fishing. A recent review of European Artificial Reef research[3] indicates that artificial reef research programmes have been initiated in eight European Union Member States, Scandinavia and the Baltic States.

A great deal of literature has built up on artificial reefs, but most work so far has a biological focus. This is understandable as each new reef deployed is unique (often differing from others in terms of shape, scale, material and always location) and therefore provides marine biologists with an excellent opportunity to study colonisation and ecosystem development. For coastal communities in Scotland that may be considering possible routes towards sustainable development, there are other issues to clarify.

[2] Jensen A et al. European Artificial Reef Research Network (EARRN): Final Report and Recommendations. Published by the University of Southampton, June 1998.
[3] Jensen A. & Collins, K. 1998, Artificial Reef Research in the European Union: A review.

The purpose of this study is to inform local development agencies and community leaders of the development potential offered by artificial reefs. The costs and risks attached to such initiatives should however be considered alongside potential benefits, and the ownership and management structures that might prove most useful in capitalising on those benefits. An important facet of the information being presented is identifying where the risks in the development are likely to lie, and what strategies could be explored to reduce or minimise those risks.

It is useful to present a brief overview of the various reasons behind the creation of artificial reefs, the range of services they provide, and how successful they are / have been at delivering anticipated benefits. These are discussed and considered from a Scottish viewpoint.

The report looks beyond the benefits that might accrue or be expected to accrue from the type of artificial reef being deployed in Loch Linnhe as these are discussed in the research emanating from the Loch Linnhe reef programme. Future Scottish artificial reefs are likely to be created with different objectives and under different circumstances.

In an increasingly litigious society the extent of liability for those deploying an artificial reef must be considered. So too should the subsequent ownership of a structure and the natural resources associated with it.

1.3 Scottish coastal communities

Scotland's coast extends to over 10,000 km of which over 6,000 km is island coastline; moreover nowhere in Scotland is more than 65km from the coast. A significant proportion of Scotland's population lives on or adjacent to the coast and thousands derive their livelihoods from marine or coastal activities; it is also a major focus for recreation[4].

Despite Scotland's close association with the coast, the sixteen coastal areas of Scotland are characterised by a significantly aged population and are expected to experience population decline. Although the primary sector was found to still be of importance to the coastal economy, the most dominant economic sector was wholesale, retail and repairs (accounting for 23% of coastal business). Other findings include relatively low income levels, high levels of deprivation in several coastal areas, a decline in unemployment over recent years and a higher number of people employed in crafts, trades and manual labour than the Scottish average.

The ability of these coastal areas to overcome the social disadvantages mentioned above is dependent upon an ability to develop effective local partnerships that are geared towards improved social capital and economic growth[5].

1.4 Coastal planning

There has been a fundamental change in the use of the sea. Traditional uses (navigation and fishing) do not require exclusive access. However modern uses, such as aquaculture,

[4] Scottish Executive. 2000. National Planning Policy Guidelines, #13 – Coastal Planning.

[5] University of Aberdeen, School of Resources, Environment and Society, 2002. Scottish Coastal Socio-Economic Scoping Study. Research findings No. 24 / 2002.

oil development, wind and wave power, necessitate exclusive use of defined portions of the seabed and overlying waters. This points to a need for a new regulatory framework.[6]

A revised NPPG 1 (17) –The Planning System – issued in November 2000 now recognises that development plan policies "should make connections to related projects and programmes ... such as … schemes for integrated coastal zone management".[7] Authorities are also encouraged to develop policies that differentiate between developed, undeveloped and isolated coasts. A variety of coastal engineering projects are defined in the guidelines, but artificial reefs are not referred to explicitly. The Scottish Coastal Forum published a legislative review of foreshore and seabed planning consents[8] in 2001, and here too artificial reefs are not discussed specifically, but many are assumed to be similar to other seabed structures.

For statutory planning purposes the limit of the coastal zone in the seaward direction is currently the Mean Low Water Mark of Ordinary Spring Tides. This is, however, soon to be extended to coastal waters with the introduction of the Water Environment and Water Services Bill[9]. It is recognised by coastal planners that it is not sufficient to simply extend land planning arrangements below the low water mark into the coastal zone, and it is this aspect of the change that remains a topic of debate.

The main part of the bill requires the drafting of river basin management plans overseen by River Basin Advisory Groups. The resulting structure should involve local communities to a greater extent and encourages more strategic planning with the need to consider cumulative impacts.

Scottish coastal communities will soon have a more integral role in the coastal planning process, but there is a distinct difference between communities reacting to proposed developments and proposing such developments themselves. For such decisions to be made by communities, certain aspects of coastal developments, including artificial reefs, must be addressed. This report intends to be the first step in developing these lines of discussion among coastal communities in Scotland.

[6]Scottish Coastal Forum, 2002 "Planning below low water.: workshop 2 – scope of planning powers" seminar, June 2002

[7] Cox. M., 2001 "Devolution in Scotland: The effect on coastal policy", Paper presented to "Coastal Management for Sustainability – Review and Future Trends" Conference, London, 24th - 25th January.

[8] Cox. M., 2001 "Foreshore and seabed development consents: legislation overviews" Scottish Coastal Forum.

[9] see http://www.scottish.parliament.uk/parl_bus/legis.html#57

2. Types of benefit

Artificial reefs are deployed for a wide variety of reasons. The huge variation in designs and materials reflects the varied purposes and intended benefits. Below is presented a summary of the benefits of artificial reefs as stated in the OSPAR artificial reef guidelines (see Annex 1).

2.1 Reduction of flooding and coastal erosion

With expected rises in sea level and increasing storm activity taking place in the northern hemisphere (as well as the rest of the world), coastal erosion and flooding have become issues of utmost importance to coastal communities.

The introduction of cost benefit analysis to coastal defence engineering has seen a move away from hard coastal defences, such as concrete seawalls, to an approach which looks at absorbing and dissipating wave energy before it impacts with the shoreline. Such structures are being considered in many areas of the world, and could be considered for many Scottish ports, particularly on the east coast.

Early experiments (1994) were carried out in the Maldives, using pre-formed concrete structures (SHED - Shepard Hill Energy Dissipator - blocks and Armour flex mattresses) as artificial reefs to provide stable settlement surfaces for coral on reef flats damaged by coral mining in the Maldives. These islands are low-lying and threatened by flooding as sea levels rise. These artificial reefs were serving as a settlement site for corals only 6.5 months after deployment. This programme hopes to reinstate a natural, effective sea-defence that has significant ecological value[10].

During this century it is anticipated that Scotland's climate will become wetter and stormier and sea levels will rise. This will result in an increased flood risk both inland (adjacent to rivers and smaller watercourses) and along low-lying coasts[11]. On the west coast of Scotland current sea level trends are negative between the Solway Firth and Western Isles, including the Firth of Clyde, where the rate of relative sea level fall is projected to be ~0.4 mm per year. Elsewhere on the west and north coasts, the trend is positive, at up to 3.5 mm per year from Mull to Wick. There is also evidence that Scotland will experience more frequent and stronger storms.

While there is a great deal of uncertainty associated with future flood risk and sea level rise, researchers suggest that the design levels of coastal flood protection structures should take into account the 'worst case' scenarios described. Furthermore, such structures should be designed in such a way as to readily permit future heightening, which may be necessary.

The costs for flood defence and coastal protection are large and in many instances must be borne by local authorities. This expenditure is justified when the socio-economic cost to local communities is considered. In the early 1990s, coastal flooding caused on average £0.5 million of damage annually to communities around the Firth of Clyde (including Saltcoats, Tarbert, Rothesay, Dumbarton).

Artificial reefs have been successfully deployed as sea defences to reduce wave energy. This potential use in Scotland is likely to be considered more frequently in the future as traditional defences are renewed or developed and alternative strategies considered. In

[10] Clark, S. & Edwards, A.J., 1994. Use of artificial reef structures to rehabilitate reef flats degraded by coral mining in the Maldives. Bulletin of Marine science 55 (2-3), 724-744 , 1994.
[11] Scottish Executive, 2002. Climate Change: Flooding occurrences review. Central Research Unit

narrow lochs this type of structure could be useful in cutting down storm surge that can cause flooding in low-lying coastal areas.

2.2 Providing sheltered anchorages for shipping and small boats

In conjunction with 2.1, an additional benefit of wave energy dissipation is to provide areas that are sheltered from the full force of storm waves. Such anchorages would allow exploitation of the artificial reef or the sheltered water landward of the reef in conditions where similar activities are curtailed in more exposed areas. Activities likely to benefit include water sports, sea angling, sport diving and aquaculture.

Easing the approach to the smaller ports and harbours around Scotland's coast can have significant economic benefits as the number of working days will increase for the various types of vessel (ferries, fishing boats, leisure craft, cargo).

The siting of such reefs does of course have to be carefully considered, with extensive consultation undertaken before such reefs can be installed and clearly marked on navigational charts. A balance needs to be struck between effectiveness, vessel navigation and visual impact.

2.3 Development of habitat for crustacean fisheries with juvenile restocking

The first experiments in providing artificial habitat for clawed lobsters originated in Canada and the USA.

Extensive work on the behaviour of lobsters has been carried out on the Poole Bay (SW England) artificial reef with a view to designing purpose built lobster reefs to enhance local trap fisheries. The Poole Bay artificial reef provides habitat for two commercially valuable species of crab. Mating pairs and berried specimens have been observed on the reef. Large numbers of prawns have also been found between the blocks and inside the Poole Bay reef.

There is a great deal of anecdotal evidence throughout the UK that inshore static gear fishermen are sinking various objects to alter habitat in ways they feel are beneficial for the stocks and / or the catching of their target species. In the Fal estuary, South West UK, fishermen have deployed weighted scrap tyres to provide habitat for shore crabs, making them easier to catch for use as bait.

Scottish fishermen have also taken advantage of opportunities to enhance their target fisheries where they have arisen. In time it is hoped that the Loch Linnhe reef will benefit static gear shellfish fishermen, both through stock enhancement and protection from trawling (see 2.5 below).

2.4 Providing substrate for algae or mollusc cultivation

The best example of the use of artificial reefs for mollusc culture comes from Japan, where habitat construction for bivalves has been applied for both soft and hard bottom species enhancement. The aim of these artificial reefs has been to cause stagnation and local

accumulation of drifting larvae and eggs, thereby preventing attrition and dispersal of juveniles and consequently enhancing the likelihood of their settling on local grounds.

Italian research has developed sophisticated bivalve culture in areas traditionally considered unsuitable for mussel and oyster "farming". There are suggestions that a mixture of caged fish and suspended bivalves may create a farming system that, to some extent, recycles excess food and dissolved nutrients from cage aquaculture, and provides habitat for species that act as "cleaner fish" by removing parasites from caged fish[12].

In Monaco farming of red coral (a commercially valuable, over-harvested resource) has been pioneered in artificial caves.

In Japan there are currently many projects in operation that are designed to improve the environment for seaweed settlement and growth, typically *Laminaria*. These artificial reefs involve placing substrate blocks or rocks at depths suitable for the growth of the most local seaweeds, and are often planned to include sea urchin or abalone culture[13].

Linkages with existing aquaculture are found to be beneficial in certain situations. Algae and bivalve grown on ARs successfully absorb increased nutrient loads from fish farms – though the area of seaweed needed to recycle such waste is usually grossly under-estimated. Algal beds also provide additional potentially harvestable resources.

The reef programme in Finland is looking at artificial reefs as a possible aid to fish farming waste management. The main aim is to experiment with the possibility of using artificial reefs in nutrient and biomass removal.

Israeli researchers have also investigated reefs as a means of absorbing nutrient-rich effluent emanating from marine fish farms. They concluded that "the reef structures served as a successful base for colonisation by natural fauna and flora, thereby boosting the local benthic biodiversity, and also served as effective biofilters of phytoplankton".[14]

Given Scotland's pre-eminence in offshore cage aquaculture this would seem to be an important direction to pursue. A number of Scottish fish farms are investigating the potential of biofilters such as urchins or algae. There have, however, been practical problems associated with polyculture in sea cage systems and artificial reefs deployed nearby may contribute to a solution, and very large areas of algal bed are required if such macrophytes are to act as fish farm waste filters.

2.5 Providing means of restricting fishing in areas with stocks requiring protection

Artificial reefs have been used as effective habitat protection devices, so called "anti-trawling reefs", especially in Spain and Italy, enforcing a legal prohibition on trawling in waters shallower than 50m in the Mediterranean and 100m in the Bay of Biscay. The use of ballast mattresses has allowed substantial reef structures to be placed in areas of relatively soft sediment, providing protection against physical disturbance for sensitive habitats such as seagrass beds.

[12] Jensen A et al., 1998 European Artificial Reef Research Network (EARRN): Final Report and Recommendations. Published by the University of Southampton, June 1998.
[13] Mottet, M.G., 1981. enhancement of the marine environment for fisheries and aquaculture in Japan. Technical report 69, Washington Department of Fisheries, Olympia. 1981.
[14] Angel et al, 2002. "In situ biofiltration: a means to limit the dispersal of effluents from marine finfish cage aquaculture" Hydrobiologia, February 2002, vol. 469, no. 1-3, pp. 1-10(10).

Hong Kong's huge artificial reef programme has the rehabilitating of local fish stocks as its primary aim, to be achieved by using reefs to restrict trawl activity. Additionally the decrease in trawling has allowed static gear fishermen to re-enter coastal fisheries without the fear of trawls "carrying away" their equipment. An added benefit could be an increase in the number of static gear fishermen, providing a potential route for the displaced fishermen from decommissioned larger vessels to remain in the fishing industry.

Scottish west coast fisheries could benefit from areas afforded protection from fishing effort. As well as the benefits to shellfish fisheries, inshore reefs may act as nursery areas for demersal finfish and so benefit whitefish stocks. The access arrangements to artificial reefs must, however, be carefully managed as such reefs have the potential to create additional conflict between gear types. It is up to coastal communities to determine whether the installation, location and extent of a reef are acceptable and access arrangements are acceptable.

2.6 Creating fish aggregation areas (angling and diving)

By far the largest numbers of artificial reefs have been deployed around the world for the benefit of recreational users, particularly in the USA and Australia. The State of Florida has as the number one priority for its programme to "…. enhance private recreational and charter fishing and diving opportunities"[15].

With the rise of diving as a sport within Europe there is a growing demand for access to alternate dive sites to fill in for those times when divers are not able to dive in the tropics. Reefs for use by divers are normally in less than 40m of water and quite often between 30-20m (these being the recommended safe depths for recreational divers). The reefs often provide dive sites in areas that would not otherwise be visited by sport divers, thus in some areas producing new tourism based operations.

Sport angling on artificial reefs is normally of the catch and release type. Commonly only specimen fish can be taken, all others returned. There are a number of reasons for adopting this policy including the need to ensure the sustainability of sport fishing on the reefs and to ensure continued support of such activity from the local commercial fishermen. (Inshore fishermen perceive these sites as being important nursery / conservation zones, acting in a re-stocking capacity)[16].

Scuba diving in Scotland is increasingly popular and coastal communities have benefited from diver spend close to popular dive sites. These situations have so far been a result of chance, with dive attractions such as wrecks or natural features being discovered rather than developed.

Elsewhere in the world vessels, vehicles and aircraft are all deliberately sunk to create reefs for diving or sports fishing. Deliberate sinking of vessels has been frowned upon in the UK, but recently precedents have been set in the South West of England with the possible scuttling of the HMS Scylla in Plymouth Bay.

[15] Dodrill, J., 2000. Artificial reef program summary overview. FWC Division of Marine Fisheries, Bureau of Marine Fisheries Management.
[16] Espla, A.R., 1998. Artificial reefs for habitat protection. EARRN workshop paper.

Scotland has so many good dive sites that environmentalists and SEPA may still view such actions as unnecessary, but it is a potential opportunity for local communities to increase year-round visitor contributions to the economy.

Sea-angling in Scotland is underdeveloped despite there being excellent boat-angling conditions (weather permitting) and there may also be associated opportunities for recreational reefs to enhance sports fishing development.

2.7. Replacing habitats in areas where particular substrates are under threat

This issue was discussed in depth at the EARRN meeting in 1998. Habitat restoration was considered an interesting possibility, the point was made that this type of work is difficult, specialist and expensive. Concerns were expressed that such habitat restoration activities might be abused by developers as providing a way of being seen as "environmentally responsible" - a relatively low cost "damage fix".

Amongst various reef restoration experiences described were examples where bulk dumping of waste, such as non-consolidated PFA, smothered old seabed. Others showed where similar activity had provided a means of rehabilitating a non-productive area – converting it into artificial rocky habitat. Opinions were split on this issue, with some of the view that this would be a good use of the technology, and others of the view that the original seabed structure should be retained rather than the creation of hard substrata where there had been sedimentary seabed before. It also pointed out that some environments had developed over thousands of years, like the biogenic calcareous habitats, and repair was effectively impossible.

The image below is taken from the Ecoreef® programme in Indonesia where researchers are attempting to restore coral reef habitats damaged by blast fishing and bleaching events. Coral tips were attached to the reef modules in an attempt to kick-start natural colonisation by reef-building organisms.

Scotland benefits from a highly varied marine environment which, while not pristine, is not considered to be permanently degraded. A fish farm license currently allows for an acceptable zone of impact below the cages where the substrate may show low species diversity. These areas are, however, found to recover quickly during fallow periods and the introduction of artificial substrate of any kind to assist is unlikely to be needed. The natural diversity of Scotland's coastal habitats suggests that this use of ARs will not be necessary.

Habitat recovery following major pollution incidents may benefit from reef creation, but research often finds that it is best left to natural processes.

2.8 Mitigation for habitat loss elsewhere (consequence of land reclamation)

One of the few riverine reefs to be deployed is in the brackish waters of the river Ouse in East Anglia, along with a series of coastal defence structures being built off the coast. The Ouse reef was designed as a "mattress" of branches and straw to promote invertebrate biodiversity in a barren, dredged riverbed. The intention is to mitigate the habitat lost through dredging activities by increasing habitat suitable for key portions of the ecosystem. In this aim it was successful - numbers of invertebrates increased over a three-year period.

Scottish coastal areas have not suffered from the same seawater ingress as eastern England and so mitigation has been unnecessary so far.

2.9 Production of marine resources

An artificial reef is not only a tool to aggregate fish and other organisms, but is also an ecological mechanism that offers shelter, protection, new habitats and food. This can be optimised by designing reefs with spaces between the bodies, with cavities, holes and surfaces encouraging settlement by sessile organisms.

The enhancement of natural production (rather than providing assistance to aquaculture) is very difficult to quantify. Consequently the aggregation versus production debate continues amongst artificial reef researchers.

To be effective in this role for benthic, nectobenthic and pelagic fish, it is necessary for the reef to have an adequate extent, both in the vertical and horizontal dimensions. The cost-effectiveness of creating an artificial reef large enough to have a significant production effect is highly questionable. This benefit alone is unlikely to be economically viable.

2.10 Alteration of hydrology to improve recreational activities (surfing)

Australia's Gold Coast has so far the only operating artificial reefs with this being the overriding benefit, however others are being planned and deployed around the world. The Narrowneck artificial surfing reef is now installed and monitoring suggests the surf breaks have been improved as a result. With surf tourism being a significant contributor to the economy, this was the primary benefit envisaged.

The Noosa Beach protection reef north of Brisbane was developed following concerns about the long-term costs and environmental consequences of continued 'beach nourishment' to repair the beach after periods of erosion[17].

A nearshore berm structure was designed consisting of a curved, submerged, low-gradient berm extending from the groyne and running offset but parallel to shore, eastwards towards First Point across the existing isobaths (see image below). For this structure, sand-filled geotextile sand bags were found to be the most user-friendly and cost-effective

[17] International Coastal Management, 2002 Noosa Main Beach Artificial Reef Restoration Proposal– Information Sheet.

solution. This "bagged berm" wave realignment structure would act much like a natural, submerged fringing reef with a shallow semi-protected area inshore of the reef. The bagged berm would have two functions:

- to reduce wave energy reaching the shoreline and thereby reduce sediment movement
- to realign the wave crests to reduce littoral drift to the west

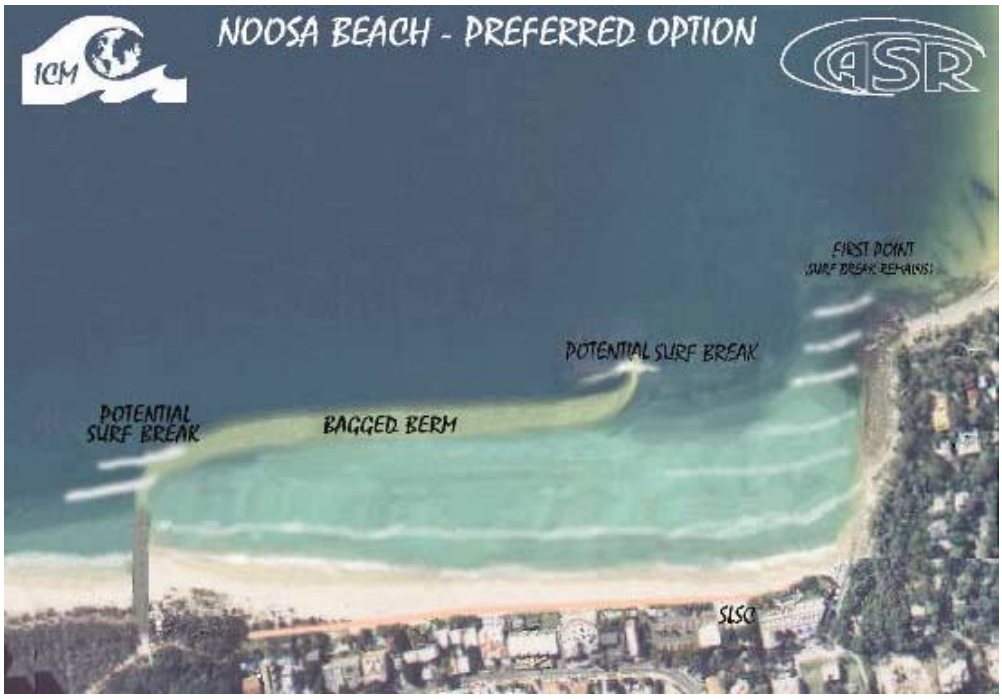
The benefits of the project include:

- By substantially reducing the size of waves reaching the protected section of shoreline, and changing the direction of the waves, loss of sand from the beach will be greatly reduced under storm conditions. This will allow a reasonable beach to be maintained on a more consistent basis, providing the outcome much sought after by the tourism industry. It will also reduce potential for damage to public and private property under cyclonic conditions.
- The submerged reef will not impact on the visual amenity of Laguna Bay.
- Construction can be from offshore, thereby minimizing disruption (concrete / rocks will not have to be transported to a works site).
- The situation can be reversed (at a cost) if there is some unforeseen serious negative impact.
- The popular First Point surf break will be maintained.
- The Noosa Woods groyne surf break will be enhanced.
- A small surf, ideal for families with younger children, will be retained.
- Requirements for sand to nourish the beach will be greatly reduced.
- Modelling indicates the beach will recover much more efficiently than the existing situation.
- A section of the beach will be retained at similar depths to the present for fitness swimming.

A number of compromises were agreed in conjunction with the Local Reference Group (tourism and community groups) and Technical Working Group (statutory authorities). These include reducing protection provided by the reef by lowering it 0.5 m for safety reasons; and shortening it so as not to affect the First Point surf break and also to retain the eastern half of the beach at more natural depths. The consequences of this will be the need for ongoing mechanical beach grooming to be undertaken.

The Noosa Beach Protection Reef was costed at between £0.7million and £1 million and was eligible for a 25% subsidy. With the reduction in the amount of beach nourishment needed, the enhancement of surfing and safeguarding of tourism revenue, the reef was deemed to be a cost-effective investment.

Two sites are being seriously considered in the UK, one in north Cornwall and another off the south Coast at Bournemouth. Both are seen as revenue earners as the aim is to provide a higher number of rideable waves. This would bring the world-class competitions to the sites, with their associated revenue streams. For the Bournemouth reef, coastal protection is an equal aim. Work has suggested that there should be a sand build up on the ocean side of the reef. Modelling would suggest that this would keep the sand in the beach system and reduce the need for expensive annual replacement and movement of sand.



©ICM, Au.

Scotland has a surprisingly vibrant surfing community that surfs a variety of breaks around the coast. The largest swells are found along the more exposed north coast with Thurso being a particular favourite. Temperature and inconsistent waves prevent surfing tourism really developing in Scotland and it is unlikely that a surf reef could be economically justified as the sole reason for construction.

2.11 As a means of safely utilising waste materials

Most reefs are built from waste materials, which are available at little or no cost. There are two main advantages in safely utilising waste materials: reduced land disposal or dumping at sea and reduced land destruction by quarry extraction.

Old vehicles

The use of "materials of opportunity" should be limited and strictly controlled. The state of Alabama requires the following to be removed from vehicles before they can be deployed as reefs[18]:

- antifreeze from radiator

[18] Szedlmayer, S., 1994 Artificial reefs design, planning and permitting. Aubern University Marine Extension & Research Centre.

- oil from the engine block
- petrol in petrol tanks
- remove excess oil on engines etc. (the no sheen rule)
- all materials that can float
- all airspaces holed out to let water in

Despite these restrictions, there is little potential to develop long-term reefs using such materials. The productive lifespan of a car body (as has been used in many US sport fishing reefs) is around 5 years. After then the structure is likely to disintegrate, resulting in a pile of rusting metal that no longer functions as a reef. A number of materials are however available that do remain intact after prolonged periods in the marine environment without deleterious effects on marine life.

Pulverised Fuel Ash – PFA

The CWARP (Coal Waste Artificial Reef Programme) in New York in the 1970's pioneered the used of cement stabilised coal ash for artificial reef construction.[19]

Experiments with the re-use of wastes such as Pulverised Fuel Ash (PFA) have shown that such materials can be stabilised with cement and used in artificial reef structures where they can support biologically indistinguishable communities when compared to control surfaces. This "high ash" cement has also been used successfully in coastal defence breakwaters[20].

In Poole Bay an experimental artificial reef was constructed in 1989 using standard sized construction blocks formed from pulverised fuel ash (PFA), flue gas desulphurisation gypsum and cement, along with concrete controls. It has been monitored for heavy metal leaching from blocks and bio-accumulation by reef associated organisms. Colonisation has been studied in detail to determine if PFA concrete is a suitable material. Coal ash is pozzolanic and thus naturally bonds with increasing length of exposure to seawater.

All results to date indicate stabilised coal ash to be a suitable material for use in the sea. Twenty years of data has not shown any negative environmental consequences that could be attributed to metal leachates from the blocks.

Although the Japanese are very much against the use of waste materials as artificial reefs, cement with a high ash content is acceptable in Japanese reefs. Additionally the use of 30% fly ash content cement in coastal defence works is commonplace on mainland Europe.

Ironically the current reduction in PFA production in UK (electricity generation is now dominated by gas fired power stations) and the large usage of PFA in Italy as a soil conditioner seem to make it unlikely that PFA will be used in large volumes as a reef material.[21]

Tyres

There is a world wide disposal problem for tyres, which are very tough and have a large void space. On land, tyre dump fires can be environmentally disastrous. Many countries,

[19] Colins, K, 1998 Artificial Reefs: Information for Sea Anglers ,University of Southampton
[20] Relini G., 1998. Artificial reefs as a means of safely utilising waste materials. EARRN Workshop paper.1998.
[21] Jensen A et al. 1998 European Artificial Reef Research Network (EARRN): Final Report and Recommendations. Published by the University of Southampton, June 1998.

especially SE Asia, Australia (open tetrahedra) and US (cement filled compressed bales - rubber rocks) have used millions of tyres for constructing reefs.

Whilst there is no evidence that tyres are environmentally harmful, there is wide concern that tyres may leach toxic compounds. The Poole Bay tyre artificial reef extension in 1998 is aimed at testing whether there is leaching and subsequent transfer of tyre chemicals to reef associated organisms.

Oil rigs

A great deal of research has been conducted on the rigs-to-reefs issue. Some environmentalists will always see such disposal as dumping with the oil companies attempting to get away without having to absorb the full costs of disposal. Environmental requirements are such that the preparation of any 'waste structure' incurs considerable costs to remove all materials deemed damaging to the marine environment such as lead, copper and petrochemicals.

A particular case is represented by oil extraction platforms that could be a nice opportunity for artificial reefs. The Norwegian government is considering such a proposal for the future use or demolition of the Ekofisk platforms. More generally, the creation of sizeable artificial reefs using redundant offshore structures is only sensible if positive impacts outweigh negative impacts[22].

The utilisation of abandoned structures like ship wrecks, platforms and stabilised recycled waste materials, could be a good opportunity for the construction of artificial reefs, but there are many problems with legislation, because of environmental concern[23].

The Brent Spar was seen by many to create the precedent upon which the rigs-to-reef debate was decided. In many respects this is unfortunate as its structure was wholly unsuitable for most artificial reef purposes, mainly consisting of a large concrete tube. Other North Sea platforms to be decommissioned would provide more suitable structures, but transport and clean-up costs make this an expensive option for an artificial reef. Their use as reefs would mainly be due to the oil companies paying for the whole process. In addition, unless it could be argued that the structure was the most suitable for the primary purpose of the reef its use would not be permitted.

UK reefs are incorporating waste or low-value material such as PFA within the matrix of reef blocks, but extensive testing of such materials in the marine environment is required. The most suitable material for the reef is necessary and while low cost material is necessary, straight waste material is unlikely to be acceptable without further processing.

2.12 Mixed use

There is considerable overlap of benefits derived from artificial reefs. As the benefits of reef developments must be illustrated to justify the costs, developers are likely to propose a variety of uses for a reef, allowing for more potential benefits to be considered.

In designing reefs, compromises may be made to ensure a reef can function as a number of things. The Noosa beach reef was designed to both enhance surf breaks and reduce beach erosion. Modelling showed that the optimal design for one function of the reef

[22] Cripps, S.J, Aabel, J.P., 2002 Environmental and socio-economic impact assessment of Ekoreef, a multiple rigs-to-reefs development. International Council for the Exploration of the Sea.
[23] O'Leary, D. O'Leary, E. Hubbard, T., 2001 Artificial reefs Feasibility Study. Marine Institute, Ireland .

differed to that suitable for another function. A design was therefore proposed which was optimal in terms of maximising the benefits – a good enough surf reef to attract visitors, while also reducing the need for beach nourishment.

Future reef developments may still have one primary purpose, but they are more likely to have a number of secondary objectives. In parallel with the need for extensive consultation, reef developments may involve a variety of stakeholders at the design stage to maximise the various benefits and also smooth the consultation process.

Coastal developments, such as offshore windfarms or coastal defences could in some instances incorporate aspects of reef design to allow subsea structures to provide a secondary function as reefs.

3. Type and scale of liability

3.1 Discussion of the issues

Improper artificial reef placement can potentially injure persons, property, and natural resources. Risks include:

- injuries to personnel handling reef materials,
- damage to vessels transporting reef materials,
- improper location causing damage to fishing gear,
- damage to vessels in transit over the reef,
- damage to buried pipelines and cables,
- injury to recreational divers,
- decomposition or movement of the reef material to an unauthorized location,
- environmental hazards caused by incomplete cleaning of used materials,
- damages to existing natural resources, such as crushing live coral reefs,
- costs involved with total removal if instructed.

The OSPAR Guidelines on Artificial Reefs, (Annex 1), suggest that competent authorities should determine what is acceptable and states, under management and liabilities, the following:

> " *31. Authorisations for constructing artificial reefs should:*
>
> *a. Specify the owner of the artificial reef and the person liable for meeting claims for future damage caused by those structures and the arrangements under which such claims can be persued against the person liable."*

The liabilities change as the reef progresses from construction through to deployment. As all reef programmes must officially notify competent agencies of the position, extent, depth etc. it is then down to the vessel-owner to avoid the reef. Complications would develop if the reef moves or changes etc..

3.2 International experiences

The USA has by far the most experience with all the liability issues involved and has an act of Congress, the National Fishing Enhancement Act of 1984, that lays out procedures[24]. Described below is a hypothetical situation that culminates in the actual placement of a reef in navigable waters of the US and discusses the liability issues as they arise:

Plan and Permit stage

The Act requires a long-term plan and establishes various criteria for the design, construction and siting of artificial reefs. The Act creates no liability on the part of the US. The suits in the Admiralty Act are the basic remedy for injuries or damage resulting from maritime actions of the Federal government. Under this statue, if the Government negligently authorized placement of a reef on top of a pipeline or undersea cable or in shallower water than intended, the US might be sued for damages. However some courts look at it differently. As a result, an intentional Federal government decision to permit a reef in a particular place, or to require certain materials for construction, would not create a

[24] US Government., 1998 Coastal Artificial Reef Planning Guide.

liability even if there were some risks involved, assuming that the explicit requirements of the Act have been satisfied.

Construction stage

When a permit has been obtained, the materials must be transported to the reef site and properly located, anchored, and marked. The Act does not address the transportation phase. Liability for transportation accidents would be the same as in any other maritime context.

The Act provides that, once title has been transferred, the donor of the materials to be used in the reef construction is immune from liability if the materials meet the requirements of the Plan and are not otherwise defective. It would therefore be in any donor's interest to verify that the materials meet the Plan requirement and to document title transfer.

The actual placement of the materials in the water will usually involve private parties, either volunteers to, or contractors of, the permit holder. Since the permit will specify the location and procedures for placing and marking, the permit holder would generally be liable for any failure to follow these specifications [(Act, section 205(c)(2)]. Conversely, strict adherence to these requirements of the permit will immunize the permit holder from liability for injuries resulting from those required activities [Act, section (c)(1)].

Monitoring stage

When a reef has been properly located, marked on navigation charts, and any required surface markers affixed, there should be very little potential for liability. Unless the reef breaks up or moves to a different location, or the marker buoys become detached, sink, or are otherwise destroyed, it would be each vessel owner's responsibility to avoid collision. The Plan suggests, and each permit may contain, requirements for systematic monitoring of each new artificial reef. To avoid liability, permit holders must follow these requirements.

Diving accidents may occur with use by recreational divers. In this respect, an artificial reef is like a public park. There are dangers in most parks, guardrails and fences cannot be placed everywhere, and everyone who visits the park assumes some risk of injury. A warning could be placed on nautical charts and posted in local dive shops to warn of the dangers. However, each case would probably involve determination of comparative negligence.

General observations

Placement of a man made reef, particularly if sponsored by a public agency, involves decisions similar to those a municipality makes in building a public park. The requirement for a federal permit and the standards and procedures of the Act, provide additional assurances that the reef will be safely located. Strict adherence to all the terms of the permit immunize the permit holder for activities the Federal Government has specified in the permit. The Federal government will generally not be liable for discretionary acts in specifying permit terms and conditions. The liability of the Federal government under the Act is no different than other forms of government activity. To minimize the risks for all concerned, the Secretary of Commerce and the Corp of Engineers should monitor and update explicit permit standards and conditions as necessary. If these conditions are not negligently devised and are properly monitored, both the Federal government and the permit holder will be protected from liability to the greatest possible degree.

3.3 Discussion in a Scottish context

Possible areas of concern:

- Structure breaks down damaging rather than enhancing habitat (physical or chemical damage)
- Structure obstructs other users (navigation for shipping etc)
- Structure has an adverse down / upstream effect

For the Loch Linnhe artificial reef, it is suggested that the licensee (SAMS) has liability during construction. Consequently it has taken out insurance of £1,000-£3,000 per annum - this amount increases as the amount of material deployed increases. Although a significant cost to a project these levels of insurance are relatively low considering the premium is based on the removal of the material, which is likely to be far more costly than deployment.

The Scottish Executive could call for removal if the structural integrity fails: either the shape changes massively or the individual blocks disintegrate, to the extent that the original purpose of the reef can no longer be realised. (As in this case the purpose is experimental, that is unlikely to happen).

No liability was necessary related to navigational accidents or other user accidents on the reef when it is in place. As long as the material is sound and it is properly marked on the charts the fault lies with the individual hitting or using the reef. When the license was granted to SAMS as it showed that there would be plenty of water (>9m) over the reef, ensuring traffic can pass freely over it.

As long as the initial objective for the reef does not change, the license will change post-deployment from marine construction to a permanent deposit license so any liability is expected to reduce or disappear. Ownership is unclear when permanent deposit status is revoked.

The general EU consensus is for complete removal as the ultimate mitigation but that seems to ignore the concept that at some point the reef would become a natural bottom structure. A simple example would be a reef caused by volcanic activity. It does eventually get fully colonised and become a functioning reef ecosystem, where one was not before. With an EIA and full stakeholder involvement in the planning process, mitigation should not be an issue.

Some EU states press for removal at any point in the lifecycle and following the end of its usefulness. The UK does not subscribe to this and authorities suggest it will ultimately take on the status of a natural reef[25].

A time period or specified conditions should be placed in statute. Simple formulae could be used such as a biodiversity index. This could be used to compare the artificial reef with a similar natural structure in the same area.

[25] Sayer, M. 2003. Pers. Com.

4. Ownership and management

4.1 Discussion of issues

The partnership structure being promoted for Scotland's coastal planning will achieve 'group ownership of issues and problems', but this is unlikely to be sufficient in a legal sense.

Existing artificial reef structures are subject to a complex legal regime drawing from numerous fields of law. This reflects a variety of influences, including different national legal systems, the purpose for which reefs are constructed, issues of property rights and measures for mitigating the impact of artificial reefs on other maritime activities and the environment. There is, however, one key characteristic in common: that while there is a need to manage fishing activities over artificial reefs (even if to prohibit fishing activities to protect spawning grounds and habitats), only rarely will developers and operators make use of fisheries management tools[26].

Ownership of the reef goes through two distinct phases. Whilst the reef is being constructed, either on shore or on the surface at its deployment site, it is very clearly the property of the entity undertaking the construction or the donor of the material being used.

Once the reef sits on the seabed inside territorial limits it should become the property of the Crown Estate in UK, but this seems to be an area of doubt. To occupy an area of seabed, for whatever reason, requires permission from the Crown Estate and may incur a rent. It therefore follows that an artificial reef will be still the property of licence holder / deployment agency.

It could be that the structure is leased back to the deployer on long-term lease. There is a very strong argument for there to be some sort of public ownership through central and local government; this could be done with the Crown gifting the seabed occupied or charging a nil rent.

If the artificial reef becomes common property the issue of restricted access is easier to deal with. There is plenty of historical precedence for the prohibiting of certain activities within certain nautical limits. In the UK, for example, as far back as 1285 the Statute of Westminster the Second pertained to closed seasons and the regulation of use of nets in salmon rivers.

The issue of historical access rights should be dealt with during any consultation process required prior to approval for deployment of an artificial reef, and may well have a bearing on whether to site a reef in a certain location.

Use and access could be controlled by local byelaw, or through the use of Regulating and Several Orders. It seems sensible to use systems where the level of involvement by local stakeholders is high such as local bylaw set by local bodies. Regulating Orders also require consensus among stakeholders.

4.2 International experience

Japan

In Japan, the old fishing communities that first discovered the usefulness of artificial reefs as far back as the 17th century gradually evolved into cooperatives that came to own the

[26] Whitmarsh, D, Pickering, H., 1997 Commercial exploitation of artificial reefs: economic opportunities and management imperatives. CEMARE

reefs outright. Today their reefs are well protected, productive resources, and managed by fishermen within a well established fisheries management structure.

Artificial reefs in Japan are considered to be public property and not private capital, though the right to exploit the benefits of these reefs is generally conferred through a system of Territorial User Rights of Fisheries (TURFs). Through these, such infrastructure as artificial reefs is placed at the disposal of specific users on a comparable basis to other professional infrastructure[27]. Such reefs and their wider fishing context are managed by the beneficiary fishermen organised in within cooperative structures through the status of Fisheries Management Organisations (FNOs). Operation is through the principles of Community Based Fisheries Management and the specific rules that the Fishermen's Cooperative Association applies in the exercise of its particular TURF.

These in effect confer property title to a particular group of fishermen, with such property rights under the relevant Japanese law, the "Current Law", only applying to sedentary species and non-mobile fishing methods. Such FMOs exercise management through a combination of resource management (including stock enhancement through hatchery and ranching activities), effort control and restricted access to grounds[28]. Whilst the national, prefecture and local public bodies fund most of the costs of artificial reef deployment, fishermen beneficiaries are expected to contribute up to ten per cent of construction costs.

Of over 1500 Fisheries Management Organisations in operation in Japan by the early 1990s, over 75 per cent were established based on specific fishing rights. Whilst by no means all of such organisations control artificial reefs within such rights, many do. Such rights tend to be most commonly issued in terms of target species such as lobster, top shell, abalone, clams, octopus, sea urchin, sea cucumber and sea weed.

The system of TURFs operated by these Fishermen's Cooperative Assocations has come into being as a direct result of the post-War modification of the laws governing the issuing of fishing rights. Since the "Current Law" regards common fishing rights in coastal fisheries as tantamount to a property right, fishermen have become more positively involved in Community Based Fisheries Management. Building on this, fishermen have been more inclined to invest in marine ranching as a means of enhancing stocks under their control.

Other international

Elsewhere, very few ownership schemes have developed. Thus, even though artificial reefs remain popular fishing sites, few of the people who fish them are directly involved in creating them.

Private ownership of marine resources can be very effective conservation tool. Around the world, however, private rights to the seabed are virtually non-existent. In 1984 US Congress passed the National Fishing Enhancement Act, which encouraged States to construct artificial reefs. Throughout much of the US, artificial reefs are created directly by state conservation departments; Alabama and Florida are two exceptions. They have begun to tap the connection between ownership and stewardship by creating limited areas where private groups and individuals could create their own reefs. Once the reefs are in the water they become public property, but the exclusive knowledge of where reefs are located allows their "owners" to benefit from the productivity of the reefs and discourages them from over fishing.

Of course, this ownership only lasts as long as the reef location remains a secret, but even this fleeting property right has resulted in a tremendous private initiative to enhance the

[27] Simard, F. 1996 Socio-economic aspects of artificial reefs in Japan. European Artificial Reef Research. Proceedings of the 1st EARRN conference. Ancona, Italy, March 1996.
[28] Ymamoto, T ., 1993 Community Based Fisheries Management in Japan, Marine Resource Economics, Volume 10, 21-34

marine environment in these states. This situation only seems possible where risks to other marine users unaware of the reef are minimal. Both states are also directly involved in artificial reef creation. The location of these reefs is public knowledge and the difference is telling. These larger structures should support larger fish, but because they are popular fishing spots, they are full of small fish - all the larger ones are fished out[29].

Artificial reefs can be used as an effective management tool for fishery resources. To be most effective they must be developed using clear, specific, realistic, and measurable objectives. With specific objectives in mind, reef developers / managers can choose and plan strategies and reef characteristics that will best meet their goals. Reef management should begin with the objectives for a reef and continue for the life of that reef. When a man-made reef has been constructed, another important phase of reef management begins: monitoring and maintenance.

The use of reefs in fisheries management is generally within a suite of management measures. Hong Kong research concluded that no studies unequivocally demonstrate enhancement of fish resources by ARs alone. However, two studies yielded increased production of invertebrates following AR deployment. In both cases the artificial reefs were specially designed, in terms of size and configuration, as shelter for the target species - one a lobster in the Caribbean, the other an octopus in Japan. The reef modules proved to be effective shelters for certain small size classes and increased their survival through particularly vulnerable early life history phases. Such 'custom -built' modules may be essential for effective stock enhancement using ARs but require detailed knowledge of the ecology of the target species; they are also likely to be expensive.[30]

Marine Fishery Reserves or Marine Protected Areas (MPAs) represent a promising approach to restoring, if not enhancing, reef fishery resources, and it may well make better economic and biological sense to develop a network of appropriately placed MPAs and do away with the expense and uncertainty of ARs. The penalties for failing to control fishing effort are also likely to be considerably less for MPAs than for ARs; at least with MPAs the fishery would be no worse than before implementation. While the introduction of MPAs will initially meet public resistance, protected areas are increasingly acknowledged to be one of the few remaining opportunities, like protected areas on land, of maintaining diversity and abundance in an increasingly impacted world.

Within the US the majority of States with sea / lake resources have some form of artificial reef programme, managed by designated managers, and administered as part of the State's marine resources or fisheries agency. Most of these managers view their constituency as sport fisherman and to lesser extent sport divers. These managers, through their State programmes, also have oversight over private and NGO reefs deployed in their States[31].

In Australia all artificial reefs require the drawing up of long-term management plans as part of the licence application (see State of Victoria licence, Annex II). The plan requires the licence-holder to show that he has sufficient resources to undertake reef removal and to conduct long-term monitoring.

[29] De Alessi, M., 1996 Private reef building in Alabama and Florida. CEI

[30] Sadovy, Y, 1999 Artificial Reefs and Marine Fishery Reserves as tools in the management of reef fisheries. in Porcupine, #19, 1999 - newsletter of the Department of Ecology & Biodiversity, The University of Hong Kong.

[31] Murray, J. 1989 A policy and management assessment of Southeast and Mid-Atlantic Artificial reef programs. UNC Sea Grant working paper.

4.3 Scottish context

The Scottish Association of Marine Science (SAMS) is managing the Loch Linnhe reef project and all licence applications are made by SAMS. Ownership is deemed to be with the licensee, but it has yet to be decided whether SAMS will hand over ownership of the reef in years to come and, if so, to whom.

At the time of writing the "Water Environment and Water Services" Bill is being put in front of the Scottish Parliament. MSPs are expected to pass the Bill, which further devolves planning responsibility to local authorities and requires consultation with the local communities. There are also suggestions from a number of Highland Council members that ownership of the coastal zone below low water should shift from the Crown Estate to the Scottish Executive.

Press releases from the Scottish Executive state the following:

> *"Statutory planning controls for marine fish farms will be introduced under local authority control ensuring that such developments are subject to local democratic scrutiny… It is also the responsibility of local authorities to consider flood alleviation solutions… SEPA will be required to consult communities, businesses and other interested parties in developing sub-basin plans and enable them to participate actively through the River Basin Advisory Groups."*

This development shifts the responsibility to local authorities for coastal planning. Artificial reefs for a variety of purposes could be proposed by private developers for consideration by the LA or could be initiated by the LA itself. Both would require extensive consultation with the local community, interest groups and relevant authorities (SEPA, SFPA, SNH, etc.).

To facilitate, formalise, and maintain good communication between interested parties, the Loch Linnhe Artificial Reef programme established two levels of project management. The function of the higher level Programme Monitoring Committee (PMC) was to represent the views of particular groups of stakeholders and regulators during the pre-deployment licensing stage. The PMC helped establish and maintain open dialogue with user groups and local people and engendered a feeling of openness and trust. Its creation also impressed local government and licensing agencies, facilitated informed debate, and created a forum through which a greater public understanding of some of the issues related to artificial reefs could be obtained. A lower level Project Working Group deals with the more practical issues relating to research and deployment aspects. Because the various groups may not share a common approach, they have chosen to have their meetings coordinated by independent facilitators (Marine Resource Initiative)[32].

It is too early to say what management system will be put in place for the Loch Linnhe reef. SAMS is looking at an ecosystem-based management of fishing effort. As the objective of the reef is stated as 'research' there is no formalised requirement for the owners to develop a fisheries management regime. Local expectation is high, however, and static gear fishermen have been assured that the area would not remain a no-take zone. No other users are anticipated at this stage – recreational diving and fishing are not major activities in the area at present, but interest and media coverage of the project may change that.

Given the structure and constraints within Scottish coastal communities, for all the benefits and risks of artificial reefs to be fully shared by all stakeholders serious thought will have to be given to the issue of ownership of artificial reef structures.

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32 Sayer, M.D.J, Wilding, T.A., 2002 Planning, licensing, and stakeholder consultation in an artificial reef development: the Loch Linnhe reef, a case study. ICES Journal of Marine Science.

The management format most likely to meet different community requirements is probably the coastal forum set-up, which has been established across Scotland since 1994. The forums are partnerships to care for coastal areas: their environment, their people and their visitors.

The Firth of Clyde Forum is an example of a potential vehicle for community involvement. The Forum is a voluntary partnership. Its membership is drawn from the 7 local authorities around the Clyde, statutory agencies such as Scottish Natural Heritage and the Scottish Environment Protection Agency, the Crown Estate, West of Scotland Water, representatives from business and industry, fisheries interests, wildlife groups such as the RSPB, the universities, local communities, and individuals with an interest in sustainable management of the Clyde.

Under the adopted principles of Integrated Coastal Zone Management (ICZM) coastal communities are recognised as having direct interest in the management of such resources since this typically impacts on their living conditions and environment. As such, consultation and decision-making structures should encourage and allow such communities to fully participate in such management. A recent assessment of the local coastal management partnerships [33] concluded that the voluntary partnership has been an effective mechanism to progress ICZM to its current state in Scotland. It is unlikely that any other mechanism could have achieved the stakeholder involvement and strategy planning as effectively as the partnership. The partnerships have achieved this on limited funding and the support of a core of dedicated partners.

The report also concluded that partnerships have yet to complete what is considered one programme management cycle. The evidence is that the partnerships are becoming less effective as they progress round this cycle and that linking the partnerships' objectives to a coherent set of national objectives will help to give them direction. In addition, effective partnerships require financial and policy support and the status these confer, as well as the backing of those stakeholders who hold statutory power for the coastal zone.

[33] Scottish Executive, 2002. Assessment Of The Effectiveness Of Local Coastal Management Partnerships As A Delivery Mechanism For Integrated Coastal Zone Management" Scottish Executive Social Research No23.

5. Revenue generation and cost-recovery

5.1 Discussion of issues

The issue of cost recovery arises where those using and benefiting from the reef, either directly or indirectly, differ to those funding the reef's creation and management. If reef developers themselves are the primary beneficiaries (aquaculture operations, fishermen, communities) there may be no need for specific cost recovery.

In order for the economic benefits of an artificial reef to be maximised, property rights and user rights would need to be clearly defined.

How to recover the costs of development, maintenance and management of artificial reefs is a continual problem faced by reef managers. Should the revenue come from general taxation, or from a community levy, or from specific user fees?

It may well be possible for costs to be met by government grants set aside to meet various international obligations such as biodiversity preservation, or for corporate donors of materials / services to gain tax advantages.

Some form of cost recovery from the perceived beneficiaries of the reef is generally attempted, even if it is only to fund the requisite monitoring and management of the reef. Covering the costs of liability insurance would also be a priority for reef managers.

Full cost recovery may, however prove unfeasible over a time-scale acceptable to most businesses. Certain reefs may be fully functional immediately after deployment, but those dependent upon colonisation may take years to mature. Contrary to most assets, however, rather than depreciating, an artificial reef designed to enhance biological production should increase benefits to users as it matures.

The concept of fees changing through the life of a reef seems one which could cause problems: does one charge a low fee first as it will take time for the reef to become a functioning eco-system; as biodiversity goes up do fees increase? Or as deployment is the most costly part of the operation does one go for a high fee up front to recover costs as quickly as possible?

A problem therefore arises when attempting cost-recovery as users on day one may be expected to pay for minimal benefits compared to users in years to come. The users must therefore see their involvement with the reef as a long-term investment. Depending upon the ownership structure, reefs intended to enhance local fisheries would be more suited to community levies and the development of a licensing system or co-operative structure that can favour those initially involved.

5.2 International experiences

The setting of user fees requires that a resource rent figure is obtained. For guidance on this matter one could look at the model used by Bonaire (Caribbean island) to tax divers using its national parks. The funds raised are used only for the maintenance of the parks and their infrastructure. The rate is set at what divers are prepared to pay. It was found that no diver disapproved of the resource rent when the funds went to the maintenance of the resource they were using. In this example the divers receive a tag, which they must display on their dive equipment. The fee is collected from the divers either up-front when they purchase their holiday or at the dive shop when they arrive. A similar method could be used for sport fishermen; a fishing licence could be issued for a particular reef in much the same way some countries / states charge fishing fees in national parks or other controlled areas.

General taxation is the route favoured by the Americans and as will be seen below, their reasoning makes sense given the figures involved.

The US States that have artificial reef programmes see them as an integral part of their marine resource management plans and fund them through State and Federal funds. As with the Japanese they are seen mainly as public infrastructure investments.

If we take South Carolina's artificial reef programme as an example, it has as a primary aim the enhancement of saltwater fishing opportunities. Thousands of resident and non-resident anglers and sport divers take advantage of the numerous artificial reefs off South Carolina each year. They pursue a wide range of year round fishing and diving activities that may not be available off South Carolina without artificial reefs. In pursuit of their interests these individuals generate nearly US$20 million dollars in total economic benefit to the State each year. This economic benefit adds significant weight to the overall cost-effectiveness of the efforts involved with maintaining a reef system[34].

The State sees a further benefit in the use of re-cycled material such as concrete pipes / pilings. Utilising these materials a substrate in the construction of artificial reefs not only saves landfill space but also allows the structures to continue to serve in a productive manner long after their intended use.

In Florida hundreds of public artificial reefs are now constructed annually, using a combination of Federal, State, local government and private funds. For the year 2000-2001 an estimated US$700,000 was spent on artificial reef construction. Since 1996, the project component of the state reef programme has been level funded with US$300,000 in Federal Aid and US$300,000 in Saltwater Fishing License revenues (only a small portion of the license revenue, 30%, shared with fishery statistics development and fish hatcheries).

A 1992 study of a single artificial reef in Lorain County, Ohio, (on Lake Erie) estimated the economic value generated by the reef during that year to be US$275,000[35].

5.3 Scottish context

The potential for full cost recovery within the Scottish coastal communities themselves is limited if the goal is to aid traditional sectors such as fishing. A resource rent could be charged but this is only likely to cover management costs. The community must determine whether the direct benefit to fishermen using the reef warrants direct charging or whether the indirect benefits to the community are enough to justify the costs.

Setting an appropriate level of rent will be difficult – particularly initially when the benefits may be largely unproven. An *ad valorem* charge – ie. £ per lobster caught on the reef - would be difficult to enforce and would create minimal revenue in the first few years. Other fishery benefits of a reef such as providing nursery habitat are also difficult to quantify.

The above issues suggest that for reefs supporting existing coastal industry such as fishing or aquaculture it is simpler if the developers are also the prime beneficiaries, or the local community recognises that such a development is beneficial to the wider community.

If the aim is to introduce new users such as divers or anglers a more direct fee could be charged, but this will also be minimal if attempting to develop new sectors.

The economic returns from an activity-based reef (sport fishing / diving) appear to be higher than a reef where the income is related to the harvesting of natural resources. Additional costs can, however, be expected in the need to develop reefs dependent upon visitors rather than users drawn from the local community. Marketing effort may be considerable as is the supporting infrastructure necessary to provide a full package to the

[34] Bell, M. 2002 Marine artificial reefs. South Carolina office of Fisheries Management.
[35] Glenn, S.J, Hushek, L.J, O'Kelch, D. 1995 Evaluations of Ohio's artificial reef. Sea Grant

visitor. The reef development should therefore be supported by a tourism and marketing strategy.

6. Conclusions

The use of artificial reefs as a fisheries development tool is expected to increase. Artificial reef polices will have to be developed that provide for management efficiency, appropriate operating funds, rational siting decisions, extensive public information and adequate evaluation.

The Loch Linnhe reef is pivotal to the future development of artificial reefs throughout Scotland as it is setting a precedent that will smooth the way for future reefs.

The Loch Linnhe reef programme's main aim is to study the reef itself. While this will always be a by-product of reef deployment to meet license requirements for monitoring, it is unlikely that licences will be awarded on this basis for future Scottish reefs. The benefits and beneficiaries will need to be clearly identified as well as how these can be managed in the long-term.

A single artificial reef may be installed to provide a number of the benefits; this will increasingly be so as the costs must be weighed up against the perceived benefits. It is anticipated that of most interest to Scottish coastal communities in the short term, focus should be on reefs designed to:

- afford coastal protection and safe anchorage;
- enhance shellfish fisheries and contribute to the control of fishing effort;
- aid aquaculture waste management for cages and diversification into shellfish culture.

Reefs may also be considered in conjunction with other coastal developments such as offshore energy – wave, tidal or wind - where the structures installed may be designed to mimic natural reefs more closely. Such design may help in mitigation of habitat loss and user conflicts.

Although there are many designs, scales and situations possible, the costs of ARs can all too easily outweigh the quantifiable benefits. This is particularly true for reefs aimed at supporting communities through enhancing local fisheries. In these instances critical to a reef's economic feasibility will be:

- additional functions of the reef and resulting benefits;
- cost of reef material (including location and transport from source);
- cost of deployment;
- arrangements for the necessary monitoring and management of the reef.

Cost recovery mechanisms associated with a small-scale inshore fishery are at best likely to be able to contribute to the management of the reef rather than the costs of creating the reef in the first place.

Interest in artificial reefs in Scottish inshore waters is currently most likely to emanate from fishery interests. On current evidence the scale of benefits that might be derived from such use is unlikely in a Scottish context to justify the likely costs of construction and management. This is particularly so when the wealth of productive inshore fishing habitats around the Scottish coast is taken into consideration. Nonetheless, there is much to be learned from the related fishery management systems that have been successfully

developed by Japan for the management of both artificial reefs and inshore fishing grounds.

Where recreational / tourism potential is considered of particular merit, then it is perhaps to the US and Australian experiences in ownership, management and crucially cost recovery, than one should turn to for information. In these examples various combinations of user rights, license fees, activity fees, and indirect taxation have been successfully used to cover the costs of reef deployment and subsequent management.

The funding requirements for these significant subsea structures may lead to reef developers emphasising the more quantifiable and comparative benefits such as those associated with coastal protection, while at the same time pointing to perceived secondary benefits such as fisheries enhancement.

The need for liability insurance, long-term management and monitoring suggests that Scottish coastal communities would need to develop artificial reefs in partnership with local government (liability), statutory authorities (management) and research institutes (monitoring).

Partnerships involving these interest groups already exist in the form of the various Scottish Coastal Forums. The role of such groups may be enhanced by the introduction of River Basin Advisory Groups as part of the Water Environment and Water Services Bill.

The introduction of the Water Environment and Water Services Bill should encourage potential artificial reef developers and ensure such developments are undertaken with the consensus of local communities.

Case studies should be developed in association with these groups to determine:

- **The needs of coastal communities - strategies to assist their sustainable development and the extent to which artificial reefs may contribute.**
- **Potential for multi-purpose reefs to maximise benefits to coastal communities.**
- **Availability of suitable material and associated costs and benefits.**

If, following the above research, it is expected that a number of artificial reefs will be developed around the Scottish coast, a set of guidelines should be developed to assist potential developers. Licence conditions should also stipulate the contents of required long-term management plans.

Annexes

OSPAR Guidelines on Artificial Reefs In relation to Living Marine Resources

(Reference number: 1999 -13)

1. Introduction

1. Artificial reefs are used in coastal waters in many regions of the world for a range of coastal management applications. The development of artificial reefs in the maritime area is still in its infancy. Among the uses being examined by the scientific community are:

   - reduction of flooding and coastal erosion;
   - providing sheltered anchorages for shipping and small boats;
   - development of habitat for crustaceans fisheries (e.g. lobsters), particularly in conjunction with juvenile restocking;
   - providing substrate for algae or mollusc cultivation;
   - providing means of restricting fishing in areas where stocks are in need of protection;
   - creating fish aggregation areas for fisheries, sport anglers and diving;
   - replacing habitats in areas where particular substrates are under threat;
   - mitigation for habitat loss elsewhere (e.g. consequence of land reclamation);
   - production of marine resources.

2. These guidelines were adopted in pursuance to Article 6 of Annex II and Article 10(d) of Annex III of the OSPAR Convention. Their purpose is to assist Contracting Parties in considering the consequences for the marine environment of the placement of artificial reefs on the seabed. Construction of artificial reefs is one example of 'placement' and the guidelines that follow contain elements that are relevant for a wide range of other coastal and offshore developments that have potential to cause adverse effects in the marine environment and that, therefore, should fall under the control of appropriate national authorities.

3. Article 1(g)(ii) of the OSPAR Convention excludes from the definition of 'dumping' the placement of matter for a purpose other than the mere disposal provided that, if the placement is for a purpose other than that for which the matter was originally designed or constructed, it is in accordance with the relevant provisions of the Convention.

4. In this regard the 'relevant provisions of the Convention' include the general obligations in Article 2, in particular the obligation that Contracting Parties shall, in accordance with the provisions of the Convention, take all possible steps to prevent and eliminate pollution and to protect the marine area against the adverse effects of human activities so as to safeguard human health and to conserve marine ecosystems and, when practicable, restore marine areas which have been adversely affected (Article. 2.1(a)). More specifically, the provisions of Article 5 of Annex II and Article 8 of Annex III which require:

(i) authorisation or regulation by the competent authority of the Contracting Parties;

(ii) that construction of an artificial reef shall not be taken to permit the dumping otherwise prohibited;

(iii) observance of the relevant applicable criteria, guidelines and procedures adopted by the Commission under Article 6 of Annex II and Article 10(d) of Annex III, respectively.

5. In addition to the provisions of these Guidelines, it may be necessary to prepare a formal 'Environmental Impact Assessment' in support of the proposal to fulfil the requirements of parallel legislation (e.g. Council Directive 85 / 337 / EEC on environmental impact assessment as amended by Council Directive 97 / 11 / EC).

6. When designing or constructing artificial reefs, due consideration should be given to relevant national and international legislation and agreements applicable to other areas e.g. waste, nature conservation and fisheries.

2. Definition and Purpose

7. An artificial reef is a submerged structure placed on the seabed deliberately, to mimic some characteristics of a natural reef. It could be partly exposed at some stages of the tide.

8. These guidelines address those structures specifically built for protecting, regenerating, concentrating and / or increasing the production of living marine resources, whether for fisheries or nature conservation. This includes the protection and regeneration of habitats.

9. Any authorisation for the creation of an artificial reef should identify clearly the purposes for which it may be created.

3. Justification and Cost / Benefit Analysis

10. Artificial reefs should only be established if, after due consideration of all socio-economic and environmental costs (e.g. undesirable impacts or alteration), a net benefit can be demonstrated, in relation to the defined objectives. In such assessment of potential effects (which may have to be a formal environmental impact assessment if major impacts cannot be ruled out) the following steps should be followed:

a) Studies should be carried out that yield the information required to assess:

- possible impacts of the installation of an artificial reef on the indigenous fauna and flora and the environment of the site and the wider surroundings;
- the benefits expected to be obtained from the installation of an artificial reef;

b) The best alternatives for the design and placement of the artificial reef should be identified. At this stage, the benefits of all options including that of no action should be assessed in relation to their socio-economic and environmental costs;

c) Before installing an artificial reef, baseline studies should be conducted to provide benchmark data for the subsequent monitoring of the effects of an artificial reef on the marine environment.

4. Requirements for Construction and Placement

4.1 Materials

11. Artificial reefs should be built from inert materials. 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. Physical or chemical weathering of structures may result in increased exposures for sensitive organisms to contaminants and lead to adverse environmental effects.
12. Materials used for the construction of permanent artificial reefs will of necessity be bulky in nature, for example geological material (i.e. rock), concrete or steel.
13. No materials should be used for the construction of artificial reefs, which constitute wastes, or other matter whose disposal at sea is otherwise prohibited.

4.2 Design

14. Modules for artificial reefs are generally built on land unless they consist solely of natural materials placed in an unmodified form.
15. The materials chosen for the construction of artificial reefs will need to 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.
16. Artificial reefs must 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.
17. Artificial reefs should be designed and built in such a way that they could be removed, if required.
18. The design of the artificial reef should strive to achieve its objectives with minimum occupation of space and interference with the marine ecosystems.

4.3 Placement

19. 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.
20. 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.
21. The location of a proposed artificial reef and the timing of its construction / placement should be carefully considered by the competent body at an early stage in the planning, especially with regard to:
    - distance to the nearest coastline;
    - coastal processes including sediment movement;
    - 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 (e.g. protected areas designated under Council Directive 92 / 43 / EEC on the conservation of natural habitats and wild flora and fauna and Council Directive 79 / 409 / EEC on the conservation of birds and under International Conventions or corresponding legislation of other Contracting Parties);
    - shipping lanes or anchorages;
    - designated marine disposal sites;
    - seabed pipelines;
    - military exclusion zones, including ordnance dumpsites;
    - engineering uses of the seafloor (e.g. potential or ongoing seabed mining, undersea cables, desalination or energy conversion sites).

22. 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.
23. It will also be important to consider information on the following:
    - 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.
24. The competent authority should ensure that the position, surveyed depth and dimensions of the artificial reef are indicated on nautical charts. In addition, the authority should ensure that advance notice is issued to advise mariners and hydrographic surveying services of the placement.

5. Administrative Action

25. No artificial reef should be placed in the marine environment without authorisation or regulation by the competent authorities.
26. The decision on the installation of an artificial reef should only be taken once the steps stipulated in § 10.a have been completed and the assessment has been evaluated. In this process, due account should be taken of the 'precautionary principle and the best environmental practice'.

6. Monitoring

27. Baseline studies should be conducted to provide benchmark data for the subsequent monitoring of the effects of an artificial reef on the marine environment.

28. The installation of an artificial reef should be followed by a short, medium and long-term monitoring programme in order to verify whether the management objectives are fulfilled and the anticipated net benefits materialise.

29. 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.

7. Scientific Experiments

30. Trials involving smaller scale placement for scientific purposes may be required before proceeding with a full scale deployment in order to evaluate the suitability of artificial reef and to assess the accuracy of the predictions of its impact on the local marine environment. As the use of artificial reefs develops, scientific experiments may be carried out. In these cases full justification referred to under section 3 may not be possible or necessary.

8. Management and Liabilities

31. Authorisations for constructing artificial reefs should:
    - *specify the responsibility for carrying out any management measures and monitoring activities required and for publishing reports on the results of any such monitoring*
    - specify the owner of the artificial reef and the person liable for meeting claims for future damage caused by those structures and the arrangements under which such claims can be pursued against the person liable.

9. Information

32. Any Contracting Party which adopts a regulation, or an individual decision, authorising the creation of one or more artificial reefs should inform the other Contracting Parties, through the medium of the OSPAR Commission, of that action and the reasons which have led to it.

Annex II: State of Victoria AR license application

APPLICATION FORM UNDER THE *ENVIRONMENT PROTECTION (SEA DUMPING) ACT 1981* FOR AN ARTIFICIAL REEF PERMIT

Introduction

The purpose of this form is to enable the assessment of the need for, and potential environmental impacts of, a proposal to place an artificial reef at sea. On the basis of this assessment the Minister may grant, or refuse to grant a permit for the proposed placement under Section 19 of the *Environment Protection (Sea Dumping) Act 1981* (the Sea Dumping Act).

As part of the application you are required to provide a long term management plan for the proposed artificial reef. As part of this, you should determine whether you and / or your organisation have sufficient resources to carry out a reef placement project and be able to monitor the project well into the future.

Under the Act, an application fee of $5000 must be forwarded before a permit may be issued. The application fee must be received within 30 days of the application being forwarded and no assessment will commence until such fees are received. The Minister may waive the requirement for payment of all or part of such fee where it is considered necessary or desirable to do so.

PART I – SUMMARY

Name of applicant:

Type of material requiring placement:

Location of disposal site:

Dates of proposed disposal operations:

Permit required by:

Quantity of material to be disposed:

Length of permit applied for in this application:

Details of previous permits applied for (include dates, quantity and whether granted / refused):

PART II - APPLICANT

1.0 Identity of applicant

Name:
Address:
Postal address (if different):
Contact person:
Phone: Fax:
Email:

2.0 Identity of the owner of the material to be disposed at sea
(if different to 1.0)

Name:
Address:
Postal address (if different):
Phone: Fax:
Email:

PART III – LONG TERM MANAGEMENT PLAN

3.0 Long term management plan

Provide a Long Term Management Plan, for the proposed artificial reef providing, but not limited to, the following information.

- A list of members of the planning group and brief notes of the meetings that have been held, outlining what was discussed, any outcomes and what actions were undertaken.
- Results of consultation with relevant Commonwealth, State and Local Government agencies and interested non-government organisations.

- The goals and / or objectives of the artificial reef project.
- A detailed map of the region showing the proposed artificial reef site, local towns, access points (for example boat ramps, marinas), and any other artificial reefs in the region.
- An assessment of the social and economic considerations as outlined in the artificial reef guidelines.
- An assessment of the environmental considerations as outlined in the artificial reef guidelines.
- An assessment of the biological considerations as outlined in the artificial reef guidelines.
- Details on:
  –preparation of materials;
  –reef design; and
  –method of construction.
- Details of the material to be used giving:
  –photographs;
  –an estimate of the total weight;
  –the source of the material;
  –the location where material can be inspected; and
  –a list of any Annex 1 or Annex II substances (under Schedule 1 of the Sea Dumping Act) that is, heavy metals, oils and grease, radioactive material, or plastics, in the material and the amounts.
- Characteristics of the proposed disposal site(s) and baseline data including:
  –a photocopied section of the relevant AUSMAP;
  –photographs and / or video of the proposed site having established markers or other suitable means to enable photographs and / or video to be taken from the same place once the reef has been placed and for future monitoring;
  –geographical position (latitude and longitude);
  –the method used to determine the geographical position of the reef once it has been placed (for example, GPS);
  –depth of water over the reef;

  –distance from nearest land;
  –biological characteristics;
  –characteristics of the sea bottom at the site, and impact of material on biota at the placement site or other areas potentially affected by the creation of the artificial reef;
  –relation of proposed site to features of importance for amenity, navigation, or exploitation of cultural, historic or scientific interest, fishing, endangered, rare or migratory species or sensitive habitats (such as coral reefs or seagrass beds);
  –data on ocean currents, tides and prevailing weather conditions; and
  –summary of the reasons for selection of proposed site.

- A draft program outlining the procedures that will be undertaken to monitor compliance with the permit, should it be granted, and to monitor the performance of the reef to determine whether:
  –project goals and objectives are being met; and
  –the reef is remaining stable and retaining its structural integrity.

PART IV - DESCRIPTION OF PLACEMENT PROCEDURES

4.0 Carrier of Material

4.1 Name and port of registration of vessel to be used for sea placement.

4.2 Owner of vessel
Name:
Address:
Postal address (if different):
Phone: Fax:
Email:

4.3 Person to be in charge of the placement operation.

4.4 Provide details of the place where the material will be loaded for transport to the placement site.

4.5 Provide details of how the material is being stored and how it will be loaded.

4.6 Date(s) of proposed loading and placement.

4.7 Placement procedures:
(a) route from loading to placement site (please provide a map as well as a description);
(b) method of placement; and

(c) if proposal is to place material more than once, give the quantity per placement and proposed frequency of placements.

4.8 Outline the method / s that will be used to prevent movement of the reef material once it has been placed.

4.9 Outline what steps will be taken to ensure diver safety both in the preparation of the material prior to sinking and over time.

5.0 Additional information for placement of vessels as Artificial Reefs.

5.1. For placement of vessels for artificial reefs give:
(a) name of the vessel to be placed;
(b) port of registration;
(c) nature and weight of ballast left on board;
(d) age of the vessel;
(e) history of use, including usual and last cargo;
(f) details of any residues including oil which may remain on board;
(g) means of transfer of the vessel to the disposal site; and
(h) intended method to be used to sink the vessel.