Guidelines for managing the collection of bait and other shoreline animals within UK European marine sites

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Contents

Tables

Appendices

Preface

The 1990s are witnessing a “call to action” for marine biodiversity conservation. The global Convention on Biodiversity, the European Union’s Habitats Directive and recent developments to the Oslo and Paris Convention have each provided a significant step forward. In each case marine protected areas are identified as having a key role in sustaining marine biodiversity.

The Habitats Directive requires the maintenance or restoration of natural habitats and species of European interest at favourable conservation status, with the management of a network of Special Areas of Conservation (SACs) being one of the main vehicles to achieving this. Among the habitats and species specified in the Annexes I and II of the Directive, several are marine features and SACs have already been selected for many of these in the UK. But to manage specific habitats and species effectively there needs to be clear understanding of their distribution, their biology and ecology and their sensitivity to change. From such a foundation, realistic guidance on management and monitoring can be derived and applied.

One initiative now underway to help implement the Habitats Directive is the UK Marine SACs LIFE Project, involving a four year partnership (1996-2001) between English Nature, Scottish Natural Heritage, Countryside Council for Wales, Environment and Heritage Service, Department of the Environment for Northern Ireland, Joint Nature Conservation Committee, and Scottish Association of Marine Science.

The overall goal of the Project is to establish management schemes on 12 of the candidate marine SAC sites. A key component of the Project is to assess the interactions that can take place between human activities and the Annex I and II interest features on these sites. This understanding will provide for better management of these features by defining those activities that may have a beneficial, neutral or harmful impact and by giving examples of management measures that will prevent or minimise adverse effects.

Seven areas where human activity may impact on marine features were identified for study, ranging from specific categories of activity to broad potential impacts. They are:

- port and harbour operations
- recreational user interactions
- collecting bait and shoreline animals
- water quality in lagoons
- water quality in coastal areas
- aggregate extraction
- fisheries

These seven were selected on the grounds that each includes issues that need to be considered by relevant authorities in managing many of the marine SACs. In each case, the existing knowledge is often extensive but widely dispersed and needs collating as guidance for the specific purpose of managing marine SACs.

The reports from these studies are the result of specialist input and wide consultation with representatives of the nature conservation, user and interest bodies. They are aimed at staff from the relevant authorities who jointly have the responsibility for assessing activities on marine SACs and ensuring appropriate management. But they will also provide a valuable resource for industry, user and interest groups who have an important role in advising relevant authorities and for practitioners elsewhere in Europe.

The reports provide a sound basis on which to make management decisions on marine SACs and also on other related initiatives such as the Biodiversity Action Plans and Oslo and Paris Convention. As a result, they will make a substantial contribution to the conservation of our important marine wildlife. We commend them to all concerned with the sustainable use and conservation of our marine and coastal heritage.

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Executive Summary

1 Introduction

The aim of this project is to describe the collection of bait (mainly ragworms, lugworms and peeler crabs) and non-bait animals from the shore, and to provide practical advice to managers of coastal sites on this activity and the range of options available for managing them, if deemed necessary. It did not include an assessment of the effects of commercial shellfish harvesting. The report brings together the scientific evidence required to support management recommendations, the management options available (as agreed with national angling bodies, NGOs, user groups, and the relevant regulatory authorities), and the legal complexities of statutory control.

2 Target species

Most of the species taken by collectors in the intertidal for personal or commercial use as bait are polychaete worms (obtained by digging or bait pumping) and peeler and softshell crabs (obtained by boulder turning or use of crab shelters in sediment areas). A rather wider range of species, predominantly molluscs, is widely collected for food and occasionally bait. The species most commonly collected, their uses and legal status are listed below. An appendix to the main report also introduces a much wider range of species that are collected from the intertidal in other countries and which occur in the UK. Some of these may increasingly be targeted in future as export markets expand and/or the cultural diversity of British communities increases.

Box 1. Commonly-collected shoreline species: their legal status and uses.

Shoreline species	**Legal definition**	**Sea Fish** (subject to fisheries legislation)		**Not Sea Fish**	
	End use	Bait	Food	Bait	Food
King ragworm *Neanthes (Nereis) virens*				✓✓	
Harbour ragworm *Hediste* (*Nereis) diversicolor*				✓✓	
Catworms or silver rag *Nephtys* species.				✓✓	
Blow lugworm *Arenicola marina*				✓✓	
Black lugworm *A. defodiens*				✓✓	
Shore or green crab *Carcinus maenus*		✓✓	✓		
Edible crab *Cancer pagurus*		✓	✓✓		
Winkles *Littorina littorea*			✓✓		
Mussels *Mytilus edulis*		✓	✓✓		
Cockles *Cerastoderma edule*			✓✓		
Carpet shells e.g. (*Venus*, *Tapes*, *Mercenaria*)			✓✓		
Razor shells *Ensis* spp.		✓	✓✓		

Sea Fish are species that are made subject to fisheries legislation. This definition includes fish, crustacea and molluscs. There is a public right to collect these species for commercial sale and for personal use from public sea fisheries throughout the UK, subject to legislative controls. Sea fish may be used for bait or for food. As far as the legislation is concerned (see part 4 of this summary), the end use is irrelevant.

Species that are not sea fish include marine worms that are often used as bait. These species do not form part of the public sea fisheries in the UK. Their collection is not regulated by fisheries legislation, nor any other statute drafted for this purpose. There is a public right to collect these species for personal use, but not for commercial sale unless with the landowner's permission.

3. Review of impacts of the collection of shoreline species

With some exceptions, the impacts of many aspects of the collection of bait and other shoreline animals are well studied and understood. The report reviews scientific literature and other sources of information on the subject. The main problems perceived are caused by negative interactions with:

- natural heritage features arising from habitat damage and alteration, damage to non-target species, and bird disturbance and prey depletion.
- fisheries - mainly damage to intertidal cockle and mussel beds.
- recreational use, harbour operations and archaeological heritage arising from habitat damage and alteration, including changes to the aesthetic appearance of dug shores and crab shelters, and issues of human safety and physical damage to vessels and structures.
- other shoreline species collectors, usually when over-exploitation of bait stocks takes place. (With only a few exceptions, bait species are very common and usually recover relatively quickly after depletion).

Further study is required to assess the impacts of collection of black lugworm *Arenicola defodiens* (relatively recently described taxonomically), peeler and softshell crab *Carcinus maenus* and other species. Such work might help to determine how to mitigate the effects of their collection on bait stocks and the marine environment.

The potential impact on nature conservation interests resulting from intertidal species collection and opportunities for mitigation and management are summarised in the following tables.

Box 2. Potential impacts of species collection and management options.

Activity	Impacts	Management options
Crab collection	• Damage to habitat and non-target species, including bird disturbance. • Safety problems and other conflicts to shore and water users. • Stock depletion unlikely to be serious, but potential impact on commercial stocks by removing undersized specimens.	• Educational programme to promote code of conduct for boulder turning. • Voluntary agreements for regulation of crab shelter numbers and locations. • Options for control under Sea Fisheries byelaws include permanent or rotational closure of areas to collection, Several or Regulating Orders, bag limits, and licensing of collectors. • Minimum sizes apply for some species. Could be extended to others.
Mollusc collection	• Damage to habitats and species. • Some populations of long-lived and slow-reproducing molluscs may be of nature conservation importance. • Collection may conflict with commercial fisheries, where not controlled by Several Order. • Digging may cause amenity or safety problems for other shore users.	• Educational programme to promote code of conduct for bag limits, minimum sizes, and/or zonation of activity. • Razor fish collection for commercial gain prohibited by local authority lease-holder in south-west Wales. • Options for control under Sea Fisheries byelaws may include permanent or rotational closure of areas to collection, controls on gear used, Several or Regulating Orders, bag limits, minimum sizes, and licensing of collectors.
Bait digging	• Potential conflict with nature conservation (non-target species and habitat damage). • May conflict with fisheries operations. • May cause damage to vessels and coastal structures. • May be incompatible with some amenity uses and harbour operations.	• Codes of conduct. • Voluntary agreements with recreational and commercial users. • Regulating extent of baitdigging (through permanent, seasonal or temporary zonation, licences, and/or bag limits). • Prohibition or regulation of commercial bait digging only. • As a last resort, prohibition of bait digging by one of a number of nature conservation agency, fisheries, local authority and harbour authority byelaws, where the activity impinges on these organisations' responsibilities.

Box 3. Concerns raised by species collection and opportunities for mitigation.

Issue	Reasons for concern	Potential for mitigation
Impacts on bird populations	• Disturbance while feeding/roosting (particularly of wintering or migrant birds) caused by presence of collectors on the shore is well documented. Scale varies: species have different tolerances to disturbance and radii of exclusion around bait diggers. • Prey species depletion, as a result of collection of target species, destruction of non-target species, or habitat and prey community change. Not as well documented.	• Difficult – bait collectors and feeding birds favour the same habitats. • No entry to areas used by feeding &/or roosting birds will be most effective. The minimum size of the exclusion zone will be dependent on the tolerance to disturbance and vulnerability of the species involved and the size and structure of the site. Need not be a permanent exclusion area.
Impacts on intertidal habitats	• Damage/change as a result of species collection is well documented for many habitats. • Sediment habitat damage from bait digging is most significant in sheltered habitats (estuaries and inlets), where holes can persist for weeks or months. Recovery is rapid in high-energy environments. Mixed sediments are seriously affected, with fine sediments lost and stones uncovered, and very slow recovery. • Overturning rocks and stones while searching for intertidal species damages this habitat. • The habitat impacts of installation of crab shelters have not been studied. They provide hard substrata in sediment areas, increasing biodiversity, but will likely alter water exchange through tidal flow and wave action, particularly after overgrowth by algae, potentially changing the nature of the habitat (research is required into their effects).	• Most effective mitigation measure is back-filling of holes and trenches left after baitdigging and levelling of any remaining spoil mounds. Recovery will still be slow in low energy environments, where exclusion zones may be necessary to retain undisturbed habitats. • Replacement of boulders turned while searching for crab is essential. • Both of the above measures are recommended in all codes of conduct but relatively rarely observed. Difficult to promote without personnel on site. Bait collectors may be best able to promote their own codes in an area. • Effects of crab shelters on habitats and potential for mitigation are unstudied. There are likely to be optimum densities of shelter placement for maximum yields and minimum habitat alteration.
Stocks of target species	• Target species are depleted by over-collection and/or through habitat damage/change that affects recovery rates. • Common, fecund, short-lived species recover quickly (blowlug *Arenicola marina*, winkles *Littorina littorea*, and most populations of king ragworm *Nereis virens*). Shore crab (*Carcinus maenus*) are likely to fall in this category, but harvesting effects are not studied. • No information is available for black lug *Arenicola defodiens* recovery rates. • Less common, slow-reproducing species are of greater concern (long-lived bivalves, white rag or catworms *Nephtys* species, and some king ragworm *N. virens* populations). Few studies of recovery of these species have been undertaken.	• Undisturbed upper shore nursery grounds, subtidal stocks or intertidal refuges are essential to maintain stock recruitment. • Backfilling will restore dug areas more quickly. • Rotational use of blowlug *A. marina* beds will maximise yields, but complex to administer and may conflict with other user group interests. • Insufficient information available to recommend similar mitigation measures for blacklug *A. defodiens*, shore crab *C. maenus* and white rag or catworms *Nephtys* species. • Artificial restocking from local brood stock reared in bait farms may be possible for many species. • Full protection is advisable for part of very long-lived, potentially slow recruiting species' populations (e.g. razor shells *Ensis* spp.).
Stocks of non-target infauna	• Non-target species are lost or depleted through physical damage or habitat change as a result of collection. • Sedentary, long-lived, slow-reproducing species will be most seriously affected. Few studies have been undertaken of recovery of such species after disturbance, but this process will be lengthy for species living for over ten years and recruiting infrequently. • Common, short-lived species recruit and recover quickly (>12 months).	• Backfilling and restoration of habitat will reduce incidental mortality. • Full protection advisable for beds of very long-lived, slow recruiting bivalves and fragile burrowing echinoderms. They will not survive intensive collection or disturbance, and may take a decade or more to recover original population structure, even if local sources of recruitment remain intact in refuges nearby.
Water quality/ pollution	• Digging sheltered sediment releases fine materials into suspension and frees heavy metals and contaminants if anoxic sediments are disturbed. Environmental effects of increased turbidity and heavy metal pollution are well documented. • Water quality/ pollution may alter target species availability and affect the health of collectors.	• Minimal potential for mitigation, other than exclusion of baitdigging from most heavily polluted sites.

4 Legal framework

As noted in section 2 of this summary, species collected on the shore are either classified as 'sea fish' (fish, crustacea and molluscs) and subject to sea fisheries legislation, or are not sea fish (these include the marine worms).

The public right to fish, which includes the collection of sea fish from the shore, is open to everybody. The collection of 'sea fish' (including peeler and soft shell crabs) may be subject to fisheries legislation. Fisheries byelaws must apply equally to all recreational, part time and full time commercial fishermen. The right of public fishery may be removed or regulated by Several or Regulating Orders, which assign some rights of fisheries to named individuals, organisations or communities, or regulate fishing methods, issue licenses, and control other activities affecting the fishery.

The collection of species other than 'sea fish' (bait worms are the most important in the UK), including the public right to take bait as an ancillary to the right to fish, is not regulated by fisheries legislation nor directly governed by any statute. This right can, however, be regulated (although not extinguished completely) by a variety of Local Authority, public health, nature conservation, Sea Fisheries Committee and Harbour Authority byelaws. Such byelaw provisions may extend below the mean low water mark.

The public right to collect bait is for personal use only. There is no legal right to take bait for commercial sale, unless private rights over certain areas of the shore exist or landowner's permission has been obtained (see below). Customary rights of bait collection are rare and very difficult to prove. In practice, it is difficult to prove whether bait is being collected for personal use or resale.

The rights of foreshore owners with regard to the collection of shoreline species are complex, and have still not fully been tested under case law. However, the 'natural products' found on the seashore belong to the owner of the shore. There is a public right only to take sea fish and bait for personal use, but not to remove other products. (An exception is if there are ancient proprietary rights associated with the ownership of coastal land over, e.g., adjacent shellfisheries – this most commonly occurs in estuaries or other inlets.) Landowners may issue licences or permits for individuals to take 'natural products', including permits for commercial bait digging. In practice, it is difficult for landowners to exert effective control over the activities of individuals collecting on their foreshore.

The legal right of individuals to install 'structures' on the shore to provide shelter for peeler and softshell crab is unclear. The right to fish on the foreshore without landowners' permission includes the right to place fishing gear there. Fishing gear must entrap 'seafish', which crab shelters do not – they simply provide habitat. Some landowners have removed crab shelters installed without permission. Others have demanded 'rent' for installation and operation in specified areas. In theory anyone may collect crabs from these shelters, but this is likely to be contended amongst collectors. Possible exceptions to this is where they have been placed under a private agreement with the landowner (giving them a legal status) or if the landowner owns rights to shellfish.

5 Management options

A wide range of management options is available and considered in Chapter 5 of the report. Options range from voluntary codes of conduct to the use of legal powers to prohibit or regulate collection. Each approach has advantages and disadvantages. In summary:

- Voluntary management offers the benefit of flexibility and simplicity, but there is the risk that they will be ignored.

- Regulations and prohibitions offer the attraction of legally enforceable controls, but may also create difficult enforcement problems for landowners and statutory bodies.

In the past, unsuccessful attempts to use voluntary forms of management or complex compromise arrangements for regulating incompatible activities on the shore have tended to escalate towards a total ban on species collection. The main reason for this is that this form of regulation is relatively easy to understand and implement and is effective. Nevertheless, the report cautions on the introduction of a collection ban other than as as a last resort for two reasons. Firstly, there is a tendency for such a ban to be followed by diversion of collection effort to other unmanaged areas where the damage caused may be more serious. Secondly, the benefits arising from a ban need to be considered against the risks of a legal challenge and the costs that may arise from this.

The successful introduction and implementation of any one of the management options identified will be dependent upon good communication with user groups. This can be difficult to achieve for those collectors who are neither part of the local community nor members of a readily identifiable national or regional user group. It also requires the provision of adequate resources for education (possibly using retail outlets), policing and, where necessary, enforcement.

Box 4. Options for managing intertidal species collection activity

Management option	Advantages	Disadvantages
National code of conduct for bait collection	• Primarily intended to influence the conduct of collection activities, e.g. by voluntary agreement on methodology of collection and informal bag limits. Potentially an extremely important and valuable means of bait collection regulation. • Should reduce conflicts with other users. • May improve yields. • May be self-regulating. • Already promoted by several user groups.	• Must be supported by resources and personnel for education and promotion, on and off-site, particularly for those who are not members of national user groups.
Local/regional code of conduct	• Potentially an important and valuable means of bait collection regulation. As above, aims may include reducing conflicts (by changing methodology or zoning activity), and improving quality and quantity of stocks. • User groups already promote several such codes, often within an estuary management plan or SAC forum. • May be self-regulating.	• Difficult to implement if some collectors are not members of recognised user groups participating in the local management forum, or are based outside the area. • Requires significant resource input for on and off-site education and promotion.
Participation of collectors in local management plans	• The management plan process for MNRs, Estuaries, SACs or other areas provides an unmatched opportunity for discussing and resolving apparent or actual conflicts between intertidal species collection and other coastal uses. It may promote sound management, through any of the techniques listed here.	• Resources required for long-term commitment to participation in the plan.
Prohibition or licensing of commercial bait collection activities	• Commercial bait collection is a potential source of conflict among bait collectors and between collectors and other users. It is not part of the public right to fish, but widely tolerated and provides an important source of bait for many anglers. • Commercial bait collection may be licensed formally by landowners (who may not, however, regulate competing non-commercial collection activities). A very few collectors have rights to collect bait commercially in specified areas.	• Extremely difficult to enforce ban because of the difficulty of proving commercial collection in court. • Loss of commercial supplies and rising retail bait prices may result in increased recreational bait collection activity and conflict with other users in many locations (collectors may supply retail outlets over a very large area).
Bag limits	• Intended to conserve stocks and reduce impacts by limiting activity, particularly commercial collection. • Generally acceptable to recreational collectors.	• Very difficult to enforce, even with resources for education and policing. • May increase collection effort.
Licensing	• No discrimination is possible; all applicants must be issued with licences and conditions applied equally. • The application licencing process ensures that all licence holders are informed of management issues and requirements.	• Successful implementation requires significant resources for education, administration and enforcement.
		Continued on next page…

Zonation	• May be voluntary or backed by legislation. Could consist of: • permanent exclusion zones (to protect core areas of reserves, recreational beach quality, coastal structures, commercial or recreational shipping infrastructure *etc.*) or • temporary, rotational zonation. The latter is likely to be more acceptable to anglers (because larger quantities of target species may be collected as areas are rotated).	• Permanent exclusion is more effective because easily understood and cheaper to administer and manage. • Rotational zonation is more difficult to enforce and will not protect habitats, coastal structures, or long-lived species.
Closed seasons	• May prevent damage to bait stocks or other wildlife at vulnerable periods, such as breeding or migrating seasons.	• Peak bait demand occurs during lugworm breeding and bird migration/ overwintering season.
Closure of bait beds	• If voluntary agreements fail, complete prohibition of collection at a site is easier for managers to administer and enforce than any other management option. • Closure must not completely stop bait collection in an area, but ensure that alternative sources remain accessible.	• Closure of a bait collection site will increase pressure on stocks and may cause conflicts at sites up to 100 miles away. Requires careful assessment of the effects of closure before introduction.
Improving retail sources of bait	• Increasing quantities of bait are now available through retail suppliers derived from farmed stocks of native species. • Imports of native bait species take place from Ireland and the Netherlands. Such imports are of great importance for angling and if good quality should reduce pressure on local stocks, but should be from sustainably managed stocks.	• Imports of non-native species (e.g. from Japan or Korea) are illegal and must actively be discouraged among retailers. • Import of unmanaged, unsustainable commercially dug worm stocks from other areas is undesirable.
Fisheries legislation	• Most shellfish already fall under the remit of Sea Fisheries Committees/MAFF and Scottish Executive Rural Affairs Department (SERAD). • Other species may be added. • Fisheries legislation and byelaws are a well-established means of controlling fisheries activities, with Fisheries Officers responsible for policing and enforcement.	• Limited resources for fisheries management will make enforcement of regulations for non-commercial collection or addition of new species to statutes an extremely low priority.

Chapter 1. Introduction

1.1 The UK Marine SACs Project

These guidelines have been prepared as part of the UK marine SACs Project. The overall aim of this Project is to promote the implementation of the Habitats Directive in marine areas through trialing the establishment of management schemes on twelve sites in the UK and by providing proven good practice and guidance to practitioners in the UK and Europe.

To support the establishment of these management schemes, the Project is undertaking a series of tasks to collate and develop the understanding and knowledge needed. One of the areas for providing guidance to those developing the schemes concerns the interaction between human activities and marine features. Human activities have an important role in the management of marine features and may have both beneficial and damaging impacts. This report is one of seven studies bringing together guidance on these impacts and promoting the means of avoiding significant damage to features, the others being:

- port and harbour operations
- recreational user interactions
- water quality in lagoons
- water quality in coastal areas
- aggregate extraction
- fisheries

1.2 Objectives and scope of these guidelines

The objectives of these guidelines are:

- to identify and agree the activity and circumstances where the impact on conservation features of the collection of shoreline animals is minimal or beneficial;
- to identify and agree the operations and circumstances where potential for adverse effect does exist;
- to identify existing guidance and procedures which can be used to exercise appropriate controls for avoiding, minimising or addressing these impacts.

These guidelines are intended to provide an accessible, comprehensive source of information on the collection of shoreline animals, the impact of this activity on certain features of the intertidal environment and opportunities for its mitigation. Their main focus is on bait collection. Other shoreline collection activities are covered to some extent because they may use similar methodology and their effects on nature conservation interests may be difficult to distinguish. It was therefore practical to address these during the same study. Seaweed collection and commercial shellfisheries are excluded – the latter is covered under a separate report (Gubbay 1999). Although primarily intended for the use of marine SAC management groups, relevant authorities, country conservation agencies, users, industry and interest groups, it should also be useful for other marine site managers and specialist interest groups in the UK and elsewhere.

The guidelines were produced following a review of literature and recent case law, investigation of examples of the management of shore line species collection through a series of case studies from the UK and overseas, and consultation with representatives of user groups, management authorities and other experts. They summarise existing knowledge on the species exploited and the potential impacts of the collection of bait and other intertidal animals (excluding commercial shellfisheries) on the intertidal marine environment. The guidelines also consider briefly some of the potential interrelationships between shoreline species collectors and other users of the intertidal, recognising that other factors will be important in determining management regimes. This information will help to determine and support management recommendations on sites where collection takes place. A very brief overview of the legal position of this activity is presented, so far as this is possible in view of the rather unclear status of bait collection and the need for legislative review, and without obtaining professional legal advice. Based on this information and reviews of case studies on the management of collection of intertidal species from the UK and in other parts of the world, the range of management options available to marine SAC management groups are identified, and their advantages and drawbacks summarised. Finally, the report highlights areas where this knowledge is inadequate.

The main reason for commissioning this study was the localised difficulty that has been encountered in the past over attempts to manage and regulate bait collection in a few UK coastal locations. Local concern over the extent of this widespread activity has been reported sporadically since the 1970s, particularly in areas with suitable bait resources that are of high nature conservation or recreational importance and close to centres of population. Management is constrained by the lack of legislation targeted specifically at the regulation of digging for worms. Whereas the collection of seafish and shellfish (the latter including all crustacea and mollusca) may potentially be undertaken using existing fisheries legislation, no legislation exists for the regulation of baitworm collection. In addition, bait collection for personal use is part of the public right to fish, which may not be extinguished under existing legislation.

The main focus of this report is, therefore, the collection of worms for use as bait by sea anglers. Although no formal data on the scale of collection exists, market surveys have estimated that some 1,000 tonnes of bait worms are used annually in the UK, the majority from wild-dug sources. The report also briefly considers the collection of peeler crabs by boulder turning or with the use of artificial crab shelters (an activity that is expanding rapidly in the south-west). Finally, the hand collection of winkles from rocky shores, and the potential for collection in SACs of a number of other marine species (albeit largely shellfish or seafish which therefore fall within the scope of fisheries legislation), are also considered.

This document was prepared by the Nature Conservation Bureau Ltd. under the guidance of a steering group comprised of representatives of the statutory nature conservation agencies, National Federation of Sea Anglers, National Association of Boat Angling Clubs, Sea Fisheries Committees, CEFAS, MAFF, DETR, RSPB, and the University of East Anglia.

1.3 Background to European marine sites

1.3.1 Habitats and Birds Directive

In May 1992, the member states of the European Union adopted to the '**Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora**'. This is more commonly referred to as the **Habitats Directive**. The main aim of the Directive is to promote the maintenance of biodiversity and, in particular, it requires member states to work together to maintain or restore to favourable conservation status certain rare, threatened, or typical natural habitats and species. These are listed in Annex I and II, respectively, of the Directive.

One of ways in which member states are expected to achieve this aim is through the designation and protection of a series of sites, known as Special Areas of Conservation (SACs).

The **Birds Directive** ('**Council Directive 79/409/EEC on the conservation of wild birds**') complements the Habitats Directive by requiring member states to protect rare or vulnerable bird species through designating Special Protection Areas (SPAs). Together, the terrestrial and marine SPAs and SACs are intended to form an coherent ecological network of sites of European importance, referred to as Natura 2000.

1.3.2 Habitats Regulations

The requirements of the Habitats Directive have been transposed into UK legislation through the Conservation (Natural Habitats &c.) Regulations 1994 and the Conservation (Natural Habitats &c.) (Northern Ireland) 1995, known as the Habitats Regulations.

Unlike on land, where SACs and SPAs are underpinned by Sites of Special Scientific Interest, there is no existing legislative framework for implementing the Habitats Directive in marine areas. Therefore the Regulations have a number of provisions specifically for new responsibilities and measures in relation to marine areas.

The Regulations place a general duty on all statutory authorities exercising legislative powers to perform these in accordance with the Habitats Directive. The term European marine site is defined to mean any SPA and SAC or part of a site that consists of a marine area, and "marine" includes intertidal areas. The new duties in connection with the management of marine sites are summarised below.

1.3.3 Management schemes

In the UK, management schemes may be established on European marine sites as a key measure in meeting the requirements of the Habitats Directive. Each scheme will be prepared by a group of authorities having statutory powers over the marine area - the relevant authorities. The Regulations set out which authorities have responsibilities for managing these sites and how they are to be managed, as described below:

- ❖ Relevant authorities are those who are already involved in some form of relevant marine regulatory function and would therefore be directly involved in the management of a marine site, and may include the following:
  - ♦ country conservation agency
  - ♦ local authorities
  - ♦ environment agencies
  - ♦ sea fishery committees
  - ♦ port and harbour authorities
  - ♦ navigation authorities
  - ♦ lighthouse authority

- ❖ A scheme may be established by one or more of the relevant authorities. It is expected that one will normally take the lead. Once established, all the relevant authorities have an equal responsibility to exercise their functions in accordance with the scheme.
- ❖ Each site can have only one management scheme.

Whilst only relevant authorities have the responsibility for establishing a management scheme, government policy (DETR guidance on "European marine sites in England and Wales") strongly recommends that other groups including owner and occupiers, users, industry and interest groups be involved in developing the scheme. To achieve this, it suggests the formation of advisory groups and a process for regular consultation during the development and operation of the scheme.

Within the Regulations, the nature conservation bodies have a special duty to advise the other relevant authorities as to the conservation objectives for a site and the operations that may cause deterioration or disturbance to the habitats or species for which it has been designated. This advice forms the basis for developing the management scheme.

The scheme will encourage the wise use of an area without detriment to the environment, based on the principle of sustainability. European marine sites have been selected with many activities already taking place and it is recognised that these are normally compatible with the conservation interest at their current levels. Only those activities that would cause deterioration or disturbance to the features for which a site has been designated need to be subject to restrictions under a management scheme.

The primary focus of a management scheme is to manage operations and activities taking place within a European marine site, promoting its sustainable use. However, it may also provide guidance for the assessment of plans and projects particularly those of minor or repetitive nature. A plan or project is any operation which requires an application to be made for a specific statutory consent, authorisation, licence or other permission. Not all types of plan or project fall within the statutory functions of relevant authorities, but are consented or authorised by other statutory bodies, termed competent authorities (e.g. central government departments).

1.3.4 UK marine SACs

In the UK, candidate SACs have been selected for ten of the marine features listed in Annex I and II of the Directive and shown below. There are presently 42 sites that have been forwarded to European Commission as candidate SACs (Figure 1).

Annex I habitat	**Annex II species**
Estuaries Large shallow inlets and bays Sandbanks which are slightly covered by seawater at all times Mud and sandflats not covered by sea water at low tide Reefs Lagoons Submerged or partially submerged sea caves	Bottlenose dolphin Common seal Grey seal

Sites have been selected for other coastal habitats or species such as saltmarsh, sand dunes or the shore dock plant. Whilst these are intertidal areas and therefore strictly European marine sites, they are generally part of ecological systems that extends above high water and come under the provisions of the Habitats Regulations relating to terrestrial SACs. For this reason, these coastal SACs lie outside the remit of this report.

1.4 How to use these guidelines

The guidelines are a detailed reference for the management of shoreline species collection. The reader is expected to use the report for guidance on specific issues. The material has been arranged to provide summary guidance at the start of each main chapter backed up by more detailed analyses following these summaries and in the appendices.

Guidance and information has been collated around three key areas as follows:

Impacts of collection activity	**Legal controls available**	**Management options**
• *Summary* Chapter 3, Table 6	• *Summary* Section 4.2	• *Summary* Chapter 5, p.64
• Summary of ecology of Target species Chapter 2, Table 1	• Powers of competent Authorities to regulate collection activities Chapter 4, Table 9	• Detailed reviews of management options Chapter 5
• Detailed review of Ecology of target species Appendix I	• Activities covered by Fisheries legislation Section 2.3.	• Case studies Appendix II
• Impacts – direct and Indirect – of bait collecting methods Chapter 3	• Role of other legal controls Chapter 4, Table 10	
• Summaries of key references Appendix III	• Wider legal context to legislative controls Appendix IV	

Candidate Special Areas of Conservation for marine interest:~

Chapter 2. Target species

2.1. Introduction

During preparation of these guidelines, a detailed review was undertaken of those species that may be targeted for collection from the intertidal of rocky and sediment shores in the British Isles. Appendix I briefly introduces, in taxonomic order, those species that are harvested in the UK, whether for bait or for human consumption and for commercial and non-commercial purposes. This section lists those species that are most commonly taken and therefore most likely to be exploited within marine SACs.

The legal status of shoreline species and their utilisation (for bait or food and personal or commercial use) is also briefly reviewed in this section.

2.2 Species most commonly collected

The vast majority of non-commercial collection of species from sediment shores in the UK is undertaken to provide fishing bait. The most common target species are burrowing polychaete worms, listed in Table 1 below. Some burrowing bivalves are also collected from sediment shores, mainly for human consumption although razor shells and possibly others are also used for bait. In the UK, the cockle is the most widely collected and consumed, but there is potential for a much wider range of bivalves to be utilised more regularly (examples are also listed in Table 1). The collection of common shore crabs from sediment shores for fishing bait is increasing.

Rocky shores are primarily used for the collection of crabs (several species, taken primarily for fishing bait) winkles (and to a lesser extent, a few other large gastropod molluscs), and mussels for human consumption and sometimes for fishing bait.

It is only the inherently conservative nature of the British diet that has restricted the species collected for food from the intertidal. Elsewhere in Europe and other parts of the world, a much wider range of species is taken. As the cultural diversity of British communities increases, site managers may expect to find an increasingly large number of species being taken, mirroring the observations made of collection on shores in south-eastern Australia (see Underwood 1993 and the New South Wales case study in Appendix II). This will be particularly likely in coastal areas close to the largest and most ethnically-diverse centres of population. Appendix I also, therefore, attempts to draw attention to species and groups of species that are currently under-utilised, or which have the potential to be collected in the future, or examples of species from families or genera with potential for collection. A few predominantly sublittoral species of high value and commercial importance are also listed, but most of the taxonomic groups that are not collected on the shore do not appear.

Table 1. The most commonly collected shoreline species

Phylum	Family	Common & scientific names	Summary of life history and ecology
Polychaeta (Bristle worms)	Nereidae, Ragworms	Harbour rag *Hediste* (*Nereis) diversicolor* King rag *Neanthes* (*Nereis) virens* Ragworm *Perinereis cultrifera*	Free-living, omnivorous, fast-growing worms which breed only once in their lifecycle before dying. They are farmed commercially for bait. Sexes are separate, and all mature worms spawn on the same day. Some mature after one year, but wild king ragworms are usually two or three years old at maturity. Usually one third or more of the population breeds each year and recruitment to the population is rapid. Some populations have much larger, older worms. These reproduce slowly and are more vulnerable to over-collection.
	Nephtyidae, Catworms or silver rag	*Nephtys caeca* *Nephtys cirrosa* *Nephtys hombergi*	Catworms actively swim and burrow in clean sand beaches in search of prey. They are long-lived, have separate sexes, and may breed several times in a lifetime. All mature worms in a population breed on the same day, but not always every year. Larvae spend up to 5 weeks in the plankton before settling onto the bottom. An average 3 inch worm is usually 4-5 years old. The largest may be up to 12 years old. Large worms are highly valued by match anglers. Their slow growth, infrequent spawning and low recruitment rates make them vulnerable to over-collection. Research into farming is underway.
	Arenicolidae, Lugworms	Blow lug, lobworm or yellowtail *Arenicola marina* Black lug or runnydown *Arenicola defodiens*	Lugworms live in U or J-shaped burrows on sandy and muddy sand shores and in the sublittoral, and feed on decaying seaweed, diatoms and bacteria. Sand casts are left above one burrow entrance. They begin to breed and are large enough for bait at 2 years old, and may live for 6 years reaching weights of 10 g (NE England) to 25 g (south and west). They breed several times during their life. Each worm spawns in a day, and all worms on a beach spawn within a few days, but those on different beaches spawn at different times. Some worms die after spawning. Others stop feeding and casting until their larvae leave the adult burrow to spend 6 months below the low water mark. They then swim to upper shore juvenile lugworm beds. Maturing worms move down the shore to adult beds. This life cycle makes most lugworm populations able to recover quickly from over-digging. Both species should soon be available from bait farms.
Crustacea	Portunidae Cancridae	Shore crab or green crab *Carcinus maenas* Velvet fiddler or velvet swimming crab *Necora puber* Edible crab *Cancer pagurus*	Crustacea grow by regularly moulting their external shells and expanding before the new shell has hardened. Crabs entering the moult are called 'peelers' and 'soft shell crabs' after moulting and before hardening. Peeler crabs release hormones that attract fish (making them very valuable as bait) so hide under rocks or other shelters to escape predators during these vulnerable stages. Bait collectors take peeler crabs of all species, including commercially fished species, but the common shore crab *Carcinus maenus* is most abundant and widely used. This species is also collected for human consumption in many parts of Europe, and for fun by 'crabbing' children. Minimum landing sizes apply to velvet and edible crabs.
Mollusca	Class Gastropoda Subclass Prosobranchia		Molluscs usually characterised by a single coiled shell, sealed by a horny operculum attached to the top of the animal's foot.
	Littorinidae, Winkles	Common periwinkle *Littorina littorea*	Winkles are common mid and low tide levels on almost all rocky shores, except on some islands. An important source of food in prehistoric times, but now mainly exported to the Continent. UK harvests are probably over 2,000 tonnes per annum. Harvesting reduces numbers and average size. Winkles usually mature at a shell height of 11-12 mm, and are harvested from 14-15 mm. Maximum size is 32 x 25 mm. Large winkles are infected by trematodes, reducing egg production, and small winkles may naturally yield most egg production. Planktonic egg capsules are laid, so recruitment to the shore may not be from a local population.
			(See Appendix 1 for more detailed information on these and other species.)

Table 1 continued. The most commonly collected shoreline species

Phylum	Family	Common & scientific names	Summary of life history and ecology
Mollusca	Class Bivalvia		Predominantly sedentary with planktonic larvae. Adults live attached to fixed substrata, in crevices, or burrowing in bottom sediments.
	Mytilidae, Mussels	Common mussel *Mytilus edulis*	Live in small groups on rocky shores or in dense beds on sediment habitats. An important food since prehistory. Collection for fishing bait is now only a fraction of levels 100 years ago. Most commercial collection is from wild stocks in sediment areas (sometimes using relayed wild seed), but there is some mussel cultivation. Length usually 50-100 mm, but sometimes only up to 30 mm, or as much 150 mm. Preferred minimum size for sale in the UK is about 55 mm. Wild mussels in Scotland are royal shellfish and Crown property.
	Ostreidae, Oysters	Flat oyster *Ostrea edulis* Pacific oyster *Crassostrea gigas*	Formerly very common, native flat oysters have virtually disappeared in the UK because of disease, habitat damage and over-exploitation. Introduced Pacific oysters sometimes breed and settle naturally onto the lower shore in the south and west. Most populations are artificially laid for culture and protected by Several Order in England and Wales, or through their status as royal shellfish in Scotland, where Crown Estate permission is required for their collection.
	Cardiidae, Cockles	Common cockle *Cerastoderma edule*	Common on all UK coasts and estuaries in sandy muds, sands and fine gravels from mid tide level to just below the extreme low water mark of spring tides. Sometimes found in extremely dense beds, and often associated with bait worms. Collected commercially by hand and mechanically, and by hand for personal consumption.
	Veneridae, Venus or carpet shells	Quahog *Mercenaria mercenaria*	A large (to 120 mm) and valuable edible bivalve, introduced into the UK from the USA and found on the lower shore and in shallow sublittoral muddy habitats. Exploited for personal use and commercially, by hand digging and dredge.
	Solenidae, Razor shells	Common razor shell *Ensis ensis*	Large (up to 130 mm long) bivalve actively burrowing in fine sand on the lower shore and shallow sublittoral. Traditionally hand collected for food and bait for personal use and for resale (usually exported for food to Europe). Recently harvested by suction dredger.
	Myacidae, Gaper shells	Sand gaper, or soft shell clam *Mya arenaria*	Large (up to 150 mm long) bivalve of high commercial importance in parts of the world (used in American clam chowder). May be extremely common in estuaries, where extensive beds are sometimes found, but apparently not widely harvested in the UK.
(See Appendix I for more detailed information on these and other species.)			

2.3 Legal status

Species collected from UK waters may, in legal terms, be divided into ‘sea fish’ and other species.

Sea fish are species that are made subject to fisheries legislation. This definition includes only fish, crustacea and molluscs (the latter two are referred to as ‘shellfish’). There is a public right to collect these species for commercial sale and for personal use from public sea fisheries throughout the UK, subject to legislative controls (including Several and Regulating Orders). Sea fish may be used for bait or for food. As far as the legislation is concerned, the end use is irrelevant.

Species that are not sea fish include marine worms that are often used as bait. These and certain other species do not form part of the public sea fisheries in the UK. Their collection is not regulated by fisheries legislation or by any other statute, but there is no public right to collect these species other than for personal use as bait. In other words, this collection must be in order to provide bait for a fishing activity and not for resale. Bait worms may only be taken commercially with the permission of the landowner (with a few exceptions where customary or private rights exist, discussed in more detail in Chapter 4). The situation with regard to the collection of other ‘non-sea fish’ species such as echinoderms, tunicates and seaweeds has not been tested in UK case law, and is outside the scope of this study.

Table 2. Legal definitions and end uses of shoreline species

Legal definition	**Sea Fish** (subject to fisheries legislation)		**Not Sea Fish**	
End Use	Bait	Food	Bait	Food
Worms			✓✓	
Crabs	✓✓	✓		
Molluscs	✓	✓✓		

Fisheries byelaws must apply equally to all recreational, part time and full time commercial fishermen. In practice, although shore crab *Carcinus maenus* is a sea fish, there is apparently no regulation of shore crab collection for bait under fisheries legislation. Other crabs, which are also taken in commercial fisheries, are subject to legal minimum landing sizes and these would apply equally to shore collection by hand. Mussels and oysters were removed from the public fishery in Scotland by The Mussels Fisheries (Scotland) Act 1847 and The Oyster Fisheries (Scotland) Act 1840. These species now belong to the Crown and rights to fish commercially for them are managed by the Crown Estate Commissioners through issuing licenses.

2.4 Utilisation of species

The collection of shore line species may be undertaken in order to yield bait for angling or food species for consumption. Some species are used for both purposes. Collection may also be undertaken on a commercial basis, being intended for resale, or for personal use by the collector or their family and friends as bait for angling or ‘for the pot’. Table 3 attempts to summarise the various end-uses of species collected by hand from the shore, taking into account availability and abundance of species listed and excluding collection under a commercial fishery.

Table 3. Estimated scale of utilisation of shoreline species collected in the UK

End use	**Fishing bait**		**Food**	
Type of collection	**Commercial***	**Personal use**	**Commercial***	**Personal use**
Ragworms	Common	Common	None	None
Catworms or silver rag	Common	Common	None	None
Lugworms	Common	Common	None	None
Shore or green crab *Carcinus maenas*	Common	Common	Exported?	Unusual
Velvet swimming crab *Necora puber*	None?	Unusual	Exported	Unusual
Edible crab *Cancer pagurus*	Unusual?	Occasional	None	Rare
Winkle *Littorina littorea*	Unusual?	Occasional?	Common	Occasional
Mussel *Mytilus edulis*	Unusual?	Occasional	Occasional?	Occasional
Oysters	None	None	Rare	Rare
Cockle *Cerastoderma edule*	None	Unusual?	Common	Occasional
Quahog *Mercenaria mercenaria*	None	None?	Common	Rare
Common razor shell *Ensis ensis*	Occasional	Occasional	Common?	Occasional
Sand gaper, or soft shell clam *Mya arenaria*	None?	None?	Rare?	Rare?

* This refers to hand collection for sale to retailers or wholesalers, and excludes licensed commercial fisheries.

In many cases, the methodology used for the collection of shore species (e.g. hand picking, digging, pumping and raking) is the same whether the immediate purpose of collection is for personal use or for re-sale. It is therefore often difficult to distinguish between the two on the ground, unless information about the scale of the collection effort is known, and even more difficult to prove. The effects of commercial collection will not necessarily be more wide-spread and intensive than collection for personal use; because there are no economic constraints on collection by individuals for their own use, diminishing returns may not lead to a reduction in effort, and hence in intertidal impacts.

Collection methodology is also similar for target species legally classified as a sea fish and therefore subject to fisheries legislation, or not subject to any existing statutes (e.g. bait worms, which are by far the most important group of animals in the context of this review). The impacts of collection, and potential for mitigation of these effects by changing collection methodology are therefore similar, even if the legal controls available for management of collection differ for ‘sea fish’ and for other species, and for the collection of bait worms for personal use or for commercial resale.

Chapter 3. The impacts of shoreline species collection

3.1. Introduction

Three 'quick reference' summary tables introduce this section. The first two outline the potential causes of impact or conflict with nature conservation interests and other coastal users arising from intertidal species collection, and the potential for mitigation of these effects. The third illustrates the potential severity of the impacts or conflicts caused by various methods of shoreline species collection on a range of environmental features and the activities of other user groups.

The summaries presented in these tables have been drawn from a detailed review of the impacts of the collection of shoreline species presented in the following pages. These describe the impacts of the most widespread collection methods for common shoreline species on the target species, non-target species, intertidal habitats, and other shoreline users; present opportunities for mitigation, and highlight shortfalls in knowledge. A tabulated literature review (Appendix III) provides details of relevant publications and other sources of information, and brief summaries of their contents.

There is a tendency for published research and unpublished reports on the impacts of bait collection activity to report significant detrimental effects. The reasons for this are that studies reviewing the impacts of bait collection are usually only commissioned in locations where a 'problem' had been identified, possibly with an aim to determining whether management was required to mitigate the effect. Such studies are most unlikely to be undertaken in locations where there is no perception of damage being caused by bait collection. Similarly, research is usually published when it has identified 'significant' (in the statistical sense) results during analysis of field data. Readers should, therefore, note that there is much less published information on studies that have shown no significant effects on wildlife caused by bait digging.

Several of the issues identified and mitigation possibilities suggested in Tables 3 and 4 may potentially result in the management of intertidal species collection. Management options available range from the promotion of voluntary codes of conduct or bag limits, to permits and licensing systems, zonation of activities, or complete closure of areas to collection. These are discussed in more detail in Chapter 5, and summarised in Table 11.

3.2 Scale of bait collection activity

The National Anglers Council (NAC) calculated the scale of bait collection activity by sea anglers in the 1970s. At this time, the NAC estimated that 75% of anglers collected their own bait, or one and a half million anglers. These included both match anglers (semi-professionals) taking very large quantities for their regular use, and the occasional angler taking some bait while on holiday. The number of active anglers in the late 1990s is considered to have risen to around 3 million, with an economic value of over £1 billion per annum. The overall number of active sea anglers, however, has apparently fallen since the 1970s and 1980s, possibly as a result of declining coastal fish stocks (C. Davies pers. comm.). Most anglers now restrict their fishing activity to inland waters and do not collect bait on the coast. Saunders *et al.* (1998) report that the National Federation of Anglers had an estimated membership of 200,000 and the National Federation of Sea Anglers 37,000 members in 1998. There are also several smaller Angling Associations, most of these regional. One million people are estimated to participate in sea fishing annually (Target Group Index 1994, quoted in Saunders *et al.* 1998), implying that no more than 25% of these are associated with national representative organisations. Saunders *et al.* (1998) also suggest that most shoreline anglers are unlikely to be associated with local clubs.

There are no reliable estimates for the numbers of active commercial bait diggers, not least because the majority of these reportedly do not declare income from this occupation. It is not essential for an angler or a commercial collector to live on the coast or near bait beds in order for bait collection to be undertaken, although most probably do. Many sports anglers will regularly drive one hundred miles or more to obtain bait for an important fishing session, and commercial bait collectors are reported to visit bait beds several hundred miles away for periods of intensive collection.

While bait worm collection is the main focus of this report, largely because of its unregulated nature and the consequent difficulty of managing the activity, a number of other species are also collected for bait or for personal consumption. The collection of peeler crabs is of particular interest in this respect, and utilises two main methods. In southwestern estuaries, anglers and commercial collectors have installed thousands of crab shelters on sediment shores. These are used to attract crabs to locations where they may more easily be collected. On rocky shores crabs are obtained by boulder turning, which may cause considerable damage to natural habitats and communities (Liddiard *et al*. 1989). Digging for bivalves also takes place on some sediment shores, and winkles and mussels are hand-gathered for food or bait on many rocky shores. The intensity of species collection for human consumption is low in comparison with many other countries (e.g. New South Wales, Australia, as described by Underwood 1993) but could increase in future.

3.3 Availability of bait supplies

Despite falling numbers of sea anglers, and evidence for a reduction in the numbers of bait collectors active in some regions during the past decade, wild bait supplies are reported by bait diggers to be increasingly scarce in some regions. The retail trade also reports that existing sources of bait from commercial bait collectors and farmed sources are completely inadequate to meet demand, both in the UK and overseas. Bait diggers consulted identify several factors thought to be responsible:

- loss of bait beds through pollution, land claim or coastal works changing current and sediment regimes;
- closure of bait beds as a result of increased restrictions by landowners and managers (e.g. in nature reserves, ports and harbours, and on recreational beaches); and
- over-exploitation of bait stocks, causing populations to dwindle in heavily exploited areas.

Thus, despite a reduction in the numbers of sea anglers, overall demand by sea anglers for wild-caught bait is high. It may even continue to rise unless bait farming significantly increases supply to domestic markets. Apart from bait digging by anglers for their personal use, future demand may be met by increased commercial bait digging or increased production from bait farms in the UK, Netherlands and Ireland, or, potentially most worryingly, imports of non-native bait species from the USA or East Asia.

Table 4. Concerns raised by species collection and opportunities for mitigation.

Issue	Reasons for concern	Potential for mitigation
Impacts on bird populations	• Disturbance while feeding/roosting (particularly of wintering or migrant birds) caused by presence of collectors on the shore is well documented. Scale varies: species have different tolerances to disturbance and radii of exclusion around bait diggers. • Prey species depletion, as a result of collection of target species, destruction of non-target species, or habitat and prey community change. Not as well documented.	• Difficult – bait collectors and feeding birds favour the same habitats. • No entry to areas used by feeding &/or roosting birds will be most effective. The minimum size of the exclusion zone will be dependent on the tolerance to disturbance and vulnerability of the species involved and the size and structure of the site. Need not be a permanent exclusion area.
Impacts on intertidal habitats	• Damage/change as a result of species collection is well documented for many habitats. • Sediment habitat damage from bait digging is most significant in sheltered habitats (estuaries and inlets), where holes can persist for weeks or months. Recovery is rapid in high-energy environments. Mixed sediments are seriously affected, with fine sediments lost and stones uncovered, and very slow recovery. • Overturning rocks and stones while searching for intertidal species damages this habitat. • The habitat impacts of installation of crab shelters have not been studied. They provide hard substrata in sediment areas, increasing biodiversity, but will likely alter water exchange through tidal flow and wave action, particularly after overgrowth by algae, potentially changing the nature of the habitat (research is required into their effects).	• Most effective mitigation measure is back-filling of holes and trenches left after baitdigging and levelling of any remaining spoil mounds. Recovery will still be slow in low energy environments, where exclusion zones may be necessary to retain undisturbed habitats. • Replacement of boulders turned while searching for crab is essential. • Both of the above measures are recommended in all codes of conduct but relatively rarely observed. Difficult to promote without personnel on site. Bait collectors may be best able to promote their own codes in an area. • Effects of crab shelters on habitats and potential for mitigation are unstudied. There are likely to be optimum densities of shelter placement for maximum yields and minimum habitat alteration.
Stocks of target species	• Target species are depleted by over-collection and/or through habitat damage/change that affects recovery rates. • Common, fecund, short-lived species recover quickly (blowlug *Arenicola marina*, winkles *Littorina littorea*, and most populations of king ragworm *Nereis virens*). Shore crab (*Carcinus maenus*) are likely to fall in this category, but harvesting effects are not studied. • No information is available for black lug *Arenicola defodiens* recovery rates. • Less common, slow-reproducing species are of greater concern (long-lived bivalves, white rag or catworms *Nephtys* species, and some king ragworm *N. virens* populations). Few studies of recovery of these species have been undertaken.	• Undisturbed upper shore nursery grounds, subtidal stocks or intertidal refuges are essential to maintain stock recruitment. • Backfilling will restore dug areas more quickly. • Rotational use of blowlug *A. marina* beds will maximise yields, but complex to administer and may conflict with other user group interests. • Insufficient information available to recommend similar mitigation measures for blacklug *A. defodiens*, shore crab *C. maenus* and white rag or catworms *Nephtys* species. • Artificial restocking from local brood stock reared in bait farms may be possible for many species. • Full protection is advisable for part of very long-lived, potentially slow recruiting species' populations (e.g. razor shells *Ensis* spp.).
Stocks of non-target infauna	• Non-target species are lost or depleted through physical damage or habitat change as a result of collection. • Sedentary, long-lived, slow-reproducing species will be most seriously affected. Few studies have been undertaken of recovery of such species after disturbance, but this process will be lengthy for species living for over ten years and recruiting infrequently. • Common, short-lived species recruit and recover quickly (>12 months).	• Backfilling and restoration of habitat will reduce incidental mortality. • Full protection advisable for beds of very long-lived, slow recruiting bivalves and fragile burrowing echinoderms. They will not survive intensive collection or disturbance, and may take a decade or more to recover original population structure, even if local sources of recruitment remain intact in refuges nearby.
Water quality/ pollution	• Digging sheltered sediment releases fine materials into suspension and frees heavy metals and contaminants if anoxic sediments are disturbed. Environmental effects of increased turbidity and heavy metal pollution are well documented. • Water quality/ pollution may alter target species availability and affect the health of collectors.	• Minimal potential for mitigation, other than exclusion of baitdigging from most heavily polluted sites.

The information presented in Table 4 is summarised from the following pages, which describe in more detail the scientific evidence for the above impacts of bait collection and cite references to source literature. Appendix III summarises the literature reviewed.

Table 5 falls outside the main scope of this review (which is concerned with the effects of species collection on the natural intertidal environment), but is included in order to present the other impacts or conflicts that may arise between bait collectors and other shoreline uses.

Table 5. Potential sources of impact or conflict between intertidal species collection and other shoreline uses, and opportunities for mitigation.

Shoreline use	Potential source of conflict with bait collection	Potential for mitigation of effects
Recreation	• Intensive bait collection on sandy beaches is unsightly. • The mounds and soft pits produced by bait digging cause potential inconvenience or even danger to bathers, walkers, and riders. • Crab shelters on soft sandy beaches may provide unexpected obstructions and cause injury.	• Infilling holes and levelling spoil mounds will resolve visual problems, but sediment may remain soft and treacherous in dug areas for several tidal cycles. • Crab shelters laid flat on sediment are less dangerous than those embedded at an angle. • Zonation of digging or crab collecting and other beach activities is an important option for mitigation. • Some local authorities use byelaws to control bait collection on recreational beaches.
Landscape	• The visual appearance of excavated holes and spoil heaps from bait digging, or numerous peeler crab shelters in muddy estuaries is often of concern to visitors and local residents.	• Infilling holes and levelling spoil mounds will improve appearance of bait beds. • Crab tiles laid flat on sediment are less visually obtrusive than when driven in at an angle.
Heritage/ archaeology	• Collection (digging/stone turning) is known to cause damage to intertidal archaeological sites, such as fish traps, wrecks, or field walls and other drowned structures.	• Mitigation of damage caused by digging large holes or overturning stones in archaeological sites unlikely to be possible. Exclusion will be necessary.
Launching, mooring and navigation	• Digging may undermine slipways and moorings, causing problems (even danger) when vessels launched across the shore. • Crab aggregation devices (tiles, pipes and tyres) protruding from soft sediment may potentially cause damage to beached or moored vessels, inconvenience or injury to individuals wading to boats, and obstruct navigation channels or anchorages.	• Incompatibility of these activities indicates that zonation could be appropriate to separate bait digging and/or the installation of crab shelters from coastal structures, moorings, anchorages and navigational channels. • Zonation may be undertaken by voluntary agreement or byelaw. • Harbour Authorities are increasingly concerned by these activities, and many now control them under byelaw.
Coastal structures	• Bait digging may undermine or cause damage to coastal or flood defences, jetties and other structures.	• As above. • Byelaws are already in use in many areas to control bait digging near coastal structures.
Commercial fisheries	• The impact of intertidal collection on commercial species, whether removal of undersized individuals or loss of prey populations, is not well studied or understood. • Habitat effects, which could affect areas or species covered by Several Order, are described above.	• Effects not well understood, but likely to be minor in comparison with the direct effects of commercial fisheries on stocks under consideration. • Mitigation measures will depend on species involved.

Table 6. Potential for interaction between shoreline species collection and other users

Coastal features or user groups potentially affected by shoreline species collection

Type of species collection or associated activity	Birds	Habitats	Target stocks	Non-target spp.	Pollution	Recreation	Landscape	Archaeology	Launching	Moorings	Coastal or flood defence	Navigation	Fisheries
Worm pumping at LWST on exposed sandy beaches	Possible		Probable	Possible									
Worm digging, sheltered to moderate exposed shores	Probable	Probable	Probable	Probable	Possible	Probable	Probable	Possible	Probable	Possible	Possible		Possible
Worm digging on very sheltered mixed sediments	Probable	Probable	Probable	Probable	Probable	Possible	Probable	Possible	Probable	Probable	Possible		Possible
Worm digging – *Nephtys* spp., mod. Exposed shores	Probable	Probable	Probable	Probable	Possible	Possible	Possible	Possible	Possible	Possible	Possible		Possible
Bivalve digging	Possible	Probable	Probable	Probable	Possible	Possible	Possible	Possible	Possible	Possible			Possible
Winkle collection from rocky shores	Possible	Probable	Probable	Probable		Possible	Possible	Possible	Possible				Possible
Stone turning	Possible	Probable	Probable	Probable				Possible	Possible				Possible
Installation and use of peeler crab shelters (tiles *etc*.)	Probable	Probable	Probable	Possible	Possible	Probable	Probable	Possible	Probable	Probable		Probable	Possible
Bait dragging on mud flats, from boats at high tide		Probable	Probable	Probable	Probable		Possible	Possible		Possible			Possible
Introduction of non-native bait species imported/farmed	Possible	Possible	Possible	Possible									Possible

Shading indicates the potential likelihood of a negative interaction taking place between shoreline species collection and nature conservation features or other users. Any effects of bait collection may vary greatly between sites.	None or unlikely	Possible	Probable

Table 6 provides a matrix illustrating the potential severity of the impact or conflict that may arise as a result of intertidal species collection. It is a rough indication of effect only, and the conflicts, if any, which may be experienced at any one site as a result of the activities listed, will vary greatly from site to site. A blank version of such a matrix may be a useful approach for management committees when considering the range of activities underway within their local site, and the likely impact of these on other uses. The matrix may be shaded according to the extent of the activity at their site, and would be expected to demonstrate a lesser overall effect than indicated above.

3.4. Hand digging

3.4.1 Methods

Lugworms (*Arenicola* spp.) and rag worms (*Nereis* and *Nephtys* spp.) are traditionally collected by using a fork (occasionally spade) to hand dig over the lower shore of a beach where dense worm beds are present. Each spit of sand is turned over and quickly searched for worms. Where bait species are more sparsely distributed, a more productive method of collection is to search for the signs of burrows of individual animals (i.e. the largest king ragworms *Nereis virens*) or investigate several areas by digging small holes in order to find a site with a population worth exploiting. Other large burrowing species (razor shells *Ensis* spp. and other bivalves) are dug in much the same way, usually after finding signs of their siphons. Black lugworms *Arenicola defodiens* are dug individually, sometimes using a specially adapted spade, to extract them from about an arm's length depth, but most are now taken by bait pump (see separate section, below).

Slightly different methods may be used by different groups of bait collectors:

Professional and experienced local bait diggers work methodically over a large area of sand (Blake (1979) estimated 200 m^2 per tide) by digging a series of adjacent trenches, which are back-filled as they proceed, and take only large worms. This is an economic method of working, minimising the disturbance to the intertidal habitat, and hence recovery of the infaunal community. The method is very efficient and removes the majority of worms in the area dug. Experienced and professional bait diggers tend to manage their activities and local bait populations. They will generally take into account the cost-effectiveness of their efforts and not over-exploit a worm bed when yields begin to fall, provided that alternative sources are available locally.

Less experienced or well-informed bait diggers, usually occasional anglers collecting for their personal use (apparently the majority seen on most beaches) dig numerous scattered holes, which are not back-filled but left open adjacent to the mounds of spoil removed from the trench. Although these bait diggers are less efficient at finding and removing lugworms than professional and experienced bait collectors, they often do not limit the size or number of worms they take and may sometimes exploit nursery areas. Many appear to be prepared to continue bait digging for as long as there are any worms available, regardless of yield per effort. This activity may cause long-term damage to bait stocks and intertidal habitats at some locations.

Collection by more mobile groups of commercial bait diggers is increasingly a source of conflict in many areas. The increasing value of and demand for bait, particularly in the autumn and winter months, has encouraged the formation of informal groups of commercial bait diggers who may travel very long distances to bait beds. Bait supply companies put together teams of bait diggers and provide their transport to new areas of shore, both locally and much further afield. One team of commercial bait diggers reportedly travelled from north-east England to south-west Scotland to dig bait for the winter market (Fowler 1992), and teams of bait diggers from Newcastle have been reported to be digging bait in Scotland during winter 1998/99 (D. Donnan pers. comm.)

Commercial bait digging gangs reportedly dig out bait populations over a period of a few days (e.g. as reported by Arnold and Arnold 1985 and 1987), and sell the worms for resale in commercial outlets, frequently a long distance away. These bait diggers do not have the same incentive to conserve the local bait resource, and may run into conflict with local anglers who take bait for their personal use, or indeed with local commercial bait diggers, over resource use. Additionally, they may not be sufficiently experienced or concerned with local habitat conservation to backfill holes and minimise damage to the habitat and shoreline species.

The increase in commercial baitdigging has resulted in conflict between competing teams of bait diggers and between local anglers and commercial bait diggers. There is some anecdotal evidence to suggest that the increase in bait digging pressures by anglers and new suppliers for the retail bait market, combined with declining local bait resources, have driven some of the traditional bait diggers out of business by over-exploiting their home areas.

3.4.2 Impacts on target species

a. Lugworms

The population biology of lugworms *Arenicola* spp. (see Appendix I) is thought to make them a particularly resilient and reliable bait species, although the life history of only one species, *Arenicola marina*, has been described in literature.

Blow lug *Arenicola marina* is widely distributed around the British coasts in suitable sediment habitats. It seems likely that most studies of lugworm collection have targeted this common species. Blow lug are particularly abundant and very resistant to heavy exploitation because harvesting adult worms for bait usually does not affect the supply of juveniles from the nursery beds elsewhere on the shore, if these areas are left untouched. They are able to recolonise dug beds by recruitment of young worms from separate nursery beds on the upper shore or by migration of adults from unexploited populations in adjacent areas (possibly including subtidal beds), provided these are not also exploited (Olive 1993).

Bait diggers usually remove only about 50% (Heiligenberg 1987) or 70% (Blake 1979a) of blow lug *A. marina* present in each area dug. Some professional and experienced bait diggers may remove more, and inexperienced diggers could be much less efficient. Studies of the recovery of lugworm beds after bait digging have indicated that complete recolonisation occurs quickly (one month after areas had been experimentally dug out at Whitley Bay: Blake 1979a). Cryer *et al.* (1987) found no significant increase in the density of worms in depopulated areas on South Wales beaches after six months during the autumn and winter. However, the initial densities at these sites were very low (9 and 16 worms/m^2), and population growth would not be expected until spring and summer.

There is only one well-documented example of a blow lug *A. marina* bed being dug out by bait collectors. This occurred in exceptional circumstances when a formerly protected area of Budle Bay, in the Lindisfarne National Nature Reserve, was opened to bait diggers during a period of unusually heavy commercial exploitation in the winter of 1984 (Olive 1985a, 1993). Density of worms in the most heavily dug area of 200 m x 1 km fell from 40 m^{-2} to <1 m^{-2} within a period of about six weeks. In total, about four million worms were removed. Recovery took place within a few months with immigration of worms from neighbouring areas when the bait diggers ceased to use the site, even though this was during the winter period when lugworm populations are at their lowest levels. This site was, however, a relatively small area within a large expanse of intertidal sand flats, with ample capacity for recolonisation from nearby populations. Recovery after over-digging may not be so rapid where lugworms are present on a small pocket beach, with limited opportunity for recolonisation of the dug beds by adult worms from elsewhere. If the nursery beds of small worms at the top of the beach have also been affected by digging, recruitment to the adult population will be reduced. This may have a serious long-term effect upon the worm stocks.

Black lug, *A. defodiens,* is a relatively recently described species, whose distribution has not been as well studied. Its populations appear to be confined to the lowest part of the shore on more exposed coasts and it presumably also occurs in adjacent subtidal areas, suggesting that the species is likely to be widespread in suitable habitats. If so, only part of the population will be affected by bait collection at any time. However, because black lug casts are not permanent, it is not easy to calculate population densities and depletion rates caused by collection. Additionally, worm populations at the bottom of the shore and in the shallow sublittoral are difficult to study. Possibly for this reason, no studies are known to have investigated the effects of bait digging on black lug, but it is unlikely that this species has been included in former blow lug *A. marina* studies – these have concentrated on worm populations on less exposed shores. As a result there are no published data on the impacts of collection on black lug, and its ability to recolonise from subtidal beds or nursery grounds (if any) is unknown. This species is now commonly collected by bait pumping, which is covered in a later section.

b. Ragworms, Neridae

Ragworms are quite widespread in more sheltered sediment areas. Their life cycle provides a naturally high population turnover, with the death after breeding of at least one third of the population each year followed by swift recruitment from the larvae (Brafield and Chapman 1967, Olive 1993). This enables a population to recover quickly from baitdigging, provided that some adults remain to breed. Refuge populations will usually be present in adjacent subtidal areas and will act as a source of juveniles. These species therefore have a resilient population ecology and are not considered to be threatened (with rare local exceptions) by bait digging activities.

Exploited and unexploited populations of king ragworms were studied for one year on the north-east coast of England by Blake (1979b). The densities of these populations were not significantly different, at about 15 m^{-2} in summer and 3 m^{-2} in winter, indicating that the dug population (which was most heavily exploited in the summer) was probably not threatened by bait digging.

The unusual population of king rag *Nereis virens* in boulder clay in the Menai Strait, however, exhibits delayed maturation, which has the potential to make over-digging a serious problem for this species (Olive 1993). Because only a small proportion of the worms in the population breeds each year, the impact of baitdigging may be much more severe. This is because a significant proportion of large worms are likely to be taken by bait diggers before they mature, and the small number which do mature produce a relatively small number of eggs compared with other populations (despite the millions of eggs produced by each large spawning female). The king rag population density in the Menai Strait may also be smaller than normal because of predation pressures on small worms by the largest individuals and territorial behaviour by the adults; it is certainly depressed below its carrying capacity by heavy bait digging. Olive (1987) recorded densities of 5-15 king rag per 25 m^2. Bait diggers selectively search for individual large adults and may be very efficient in taking a high proportion of the sparsely distributed worms present. In this situation, intensive baitdigging can cause a significant reduction in the worm population, particularly if there is little opportunity for recolonisation from adjacent areas on the shore or in the intertidal. Suitable habitats below the low water mark in the Strait also appear to be scarce, so a refuge population is not available to act as a source of recruitment.

Reports from anglers of massive ragworms in similar habitats elsewhere (e.g. boulder clay underlying sediment in Milford Haven) suggests that *Nereis virens* populations with these characteristics may occur elsewhere.

c. White ragworms *Nephtys* species

White rag or catworms are quite local in distribution compared with other polychaete bait species and are hard to find. Locations of worm beds are often guarded closely by diggers who recognise that their populations may easily be severely depleted by baitdigging, as a result of their slow growth, longevity, very infrequent reproduction and low recruitment rates (Olive 1985b, Caron *et al*. 1995). White ragworms are also much in demand by some anglers as bait (Olive 1993, Dyrynda and Lewis 1994). Several sea anglers and commercial bait collectors consulted have expressed concern over the over-exploitation of some populations, particularly by match fishermen and commercial collectors visiting beds from other parts of the country, and suggested that temporary closure of depleted beds would be a useful management option. This might be the case, but possibly only if successful recruitment occurred during closure.

d. Other species

Digging is also used for the collection of burrowing bivalves, including razor shells *Ensis* spp., soft shell or gaper clams *Mya* spp., quahogs *Mercenaria mercenaria,* and other carpet shells (see section 4 for descriptions of examples of these species). These may be taken for personal consumption or for fishing bait. Collection could potentially impact the target population where the species is particularly long-lived and slow to recruit, but most large species of bivalve are more commonly found below the low water mark, with only a small proportion of the total population being vulnerable to hand collection on the shore. In a few locations, however, populations of large long-lived bivalves occur in the intertidal. These may form part of an infaunal community of high nature conservation interest purely because of their unusual distribution and accessibility to researchers for scientific study and monitoring purposes. Under these circumstances, removal of this intertidal population by collectors may be of nature conservation concern, even if only a small proportion of the overall population in the area is affected. Additionally, it is possible for the entire population of a large burrowing species to be found in the intertidal, where it is vulnerable to exploitation (for example, where suitable habitats are not present in adjacent subtidal areas). Collection of such species may therefore be of nature conservation concern.

3.4.3 Impacts on habitat

Digging for bait or other infaunal species disturbs the sediment, which is removed from its original position, overturned and exposed to air and wave or current action. Transport of fine sediment and previously buried contaminants takes place at the sediment surface. Stones and shell buried in the sediment are exposed (Anderson and McLusky 1981, Anderson and Myer 1986, Farrell 1998). The effect is not confined to the areas excavated, but usually extends to an equal area covered by the excavated spoil. If the displaced mounds of sediment are subsequently returned to the trenches by the bait digger (the process of back- or in-filling), then the effect of disturbance is reduced and recovery hastened. Recovery of dug areas takes place most quickly (within three weeks) where holes and trenches are back filled (McLusky *et al.* 1983), and in the most wave-exposed areas. Sheltered sediment shores exposed only to small amounts of wave action take longer to recover.

Some of the more detailed studies on recovery of sediments were carried out in the Firth of Forth (Anderson and McLusky 1981, McLusky *et al.* 1983). These studied the recovery of areas where bait digging had been simulated. A series of holes were dug, with the mounds produced from the spoil left alongside (the method used by many amateur bait diggers), and some long trenches excavated and infilled (copying the more experienced diggers). These were monitored over a period of 30 days, with microtopography, sediments in suspension and surface sediments being studied. A similar study (Anderson and Meyer 1986) studied surface and suspended sediments after clam digging in Maine, USA. Coates (1983) and Johnson (1984) have also studied the recovery of bait dug areas in the Menai Strait.

The immediate effect of bait digging is to change the sediment stratigraphy. In undisturbed conditions, bioturbation of sediments (primarily by feeding lugworms) usually produces a layer of well-mixed sand 10 cm deep, which overlies a bed of shell or stone. The sediment may be anoxic at or below this layer, with contaminants often retained in this anoxic layer. Digging moves the coarse material and anoxic sediments to the surface, where they are exposed to the action of waves and currents and quickly oxidised, releasing pollutants (see below).

Where no back-filling takes place, the mounds of spoil are exposed to increased wave and current erosion and winnowing out of the finer sediments. The basins collect organic material (drift seaweed) and fine sediments from suspension. The result is the formation of a soft, organically enriched and anoxic layer at the bottom of the basin, which also holds water permanently. The holes initially fill in much more swiftly than the mounds erode, but the latter disappear well before the basins fill completely. Back-filled trenches recover much more quickly, but some stones and shell dug up will still be left on the surface.

Overall recovery rates will depend on the energy of the site. Thus coarse sandy beaches with wave action will lose the signs of digging much more quickly than sheltered sites with poorly sorted sediments. Storms will speed up the disappearance of bait dug areas. In the very sheltered conditions of the Menai Strait, where bait digging results in the movement of underlying boulder clay to the surface, Johnson (1984) recorded that some experimental plots were still visible one year after having been dug. In contrast, on the more exposed, muddy sand shore of Red Wharf Bay, Anglesey, unfilled holes and mounds took from 25 to 30 days to completely disappear. This is an insufficient period to enable shores to recover between the peaks of collection at each low water spring tide. (Bait diggers are now using pumps in Red Wharf Bay, and the signs of this activity are lost overnight (Mr Sharp pers. comm., see section 3.3.))

In addition to these physical effects, bait digging can cause changes to the chemical content of sediments. Howell (1985) records that increased levels of heavy metals were found in surface sediments and invertebrates following intensive bait digging in Budle Bay, where 50 diggers were estimated to turn over about 62.5 t of sediment containing 3 kg of lead and 40 g of cadmium on each tide. The exposure and subsequent oxidisation of deep sediments by digging enables these heavy metals, which are bound to sediment particles in reduced (anoxic) conditions, to become bioavailable. Cadmium is also concentrated in the anoxic layers by the activity of lugworms; their removal therefore exacerbates this problem.

Bait digging can also cause the destruction of mussel bed and eelgrass habitats on sediment areas.

These changes to the intertidal habitat also affect populations of other intertidal invertebrates.

3.4.4 Impacts on non-target species

During the process of bait collection, by hand, mechanical digging or boulder turning, many animals and plants other than those being sought will be damaged and their population levels reduced. Species populations will be affected immediately by the disturbance at the time of bait collection, but their recovery will also be dependent upon the longer-term habitat damage caused (see below).

There have been several studies on the impact of hand digging for worms on other populations of common sediment shore invertebrates (Cadee 1977, Cadman 1989, Cryer *et al.* 1987, Dyrynda and Lewis 1994, Farrell 1998, Heiligenberg 1987, McLusky *et al.* 1983). The process of digging for bait causes the death of many other marine invertebrates, by physical damage, burial and smothering or exposure to desiccation and predation. Eel grasses *Zostera* species and *Sabella* (polychaete worm) beds may also be uprooted by bait digging at the extreme low water mark (Dyrynda and Lewis 1994) and mussel beds loosened, potentially leading to their erosion and loss in bad weather.

<u>Cockles</u>

Jackson and James (1979) suggest that intensification of digging for bait worms on the North Norfolk coast in the 1950s and '60s resulted in a decline in cockle *Cerastoderma edule* populations. Undisturbed cockle beds were not affected. The cockle cannot regain its normal position at the surface of the sediment if deeply buried in overturned spoil. There have been conflicts between cockle fishermen and bait diggers in the Burry Inlet, South Wales, where Shackley *et al.* (1995) demonstrated that the effects reported from North Norfolk also occurred. These authors reported over 90% mortality of cockles in areas affected by baitdigging, with large older cockles most likely to die. Recolonisation was occurring three months after bait digging, but the cockle population structure still showed differences from undisturbed areas. Farrell (1998) also described a reduction in numbers of cockles in experimentally-dug areas of Chichester Harbour.

Small, short-lived invertebrates

Smaller, more numerous invertebrates are also affected. Cadee (1977) recorded an 85% decline in the polychaete *Heteromastus filiformis* after digging. Heiligenberg (1987) examined the effects of both hand and mechanical digging in the Dutch Wadden Sea. Hand digging caused a significant reduction in many of the common species, including *Scoloplos armiger*, *Nereis diversicolor*, *Heteromastus* and, of course, *Arenicola* (50% removal). A total of 1.9 g of other benthic animals was removed for every 1 g of *Arenicola*.

Recovery of these invertebrate populations is fairly swift, through migration into the dug areas. McLusky *et al.* (1983) found a reduction of 80-100% for the surface-living *Hydrobia ulvae* and nearly 100% for *Macoma* after hand digging, but normal populations in test plots after 15 days. Speed of recovery of infauna on mounds and in trenches will vary. Several species prefer the soft substratum found in trenches, but some species avoid both features, so a return to normal may not occur until the habitat has been restored. This is most rapid where trenches have been back-filled during bait digging. Complete recovery of most common species will take place after the successful settlement and recruitment of juveniles to the population (in less than one year).

Large, long-lived invertebrates

Long-lived, infrequently recruiting species such as large bivalves (e.g. *Mya arenaria*), acorn worms *Saccoglossus* sp. or burrowing echinoderms will take much longer to become re-established after removal or destruction during digging (e.g. Beukema 1995, Dyrynda and Lewis 1994). Some of these species are also very vulnerable to bait digging disturbance because of their fragile nature. Farrell (1998) describes the complete loss of the large sedentary worm *Amphitrite johnstoni* and *Harmathoe imbricata* (which is its commensal – living in the same burrow) from areas dug experimentally in Chichester Harbour. Numbers were still extremely low compared with the control undisturbed site a year after digging. A population of the heart urchin *Echinocardium cordatum* was badly affected by a short period of heavy bait digging at Newton Haven, a small pocket beach in Northumberland, before a byelaw to control this activity was introduced (Fowler 1992). In most cases these long-lived species will also occur below the low water mark, with only a small proportion of the population being damaged. However, the activity may still have a detrimental effect on the nature conservation importance of the site if it has been designated because of the presence of such species in the intertidal where they are accessible for scientific study and monitoring (Olive 1984).

Intertidal community effects

In a few cases where bait digging takes place in very sensitive areas, the whole sediment community may be affected. In the Menai Strait very rich infaunal populations had previously been recorded in areas which were then intensively dug for king ragworms. These diverse populations were no longer present in the disturbed areas. Management of bait digging was proposed to enable recovery of these sites and eventual recolonisation by the original full range of fauna. Eelgrass *Zostera* spp. beds and saltmarsh habitats are also damaged by bait digging, which loosens and uproots plants and may result in the beds being washed away.

There have also been instances of bait digging for ragworm taking place within mussel beds on sediment areas. The physical disturbance of the beds can result in the mats of mussels breaking up and being washed away in poor weather. Mussels provide a habitat for a wide range of species, which may also be lost, and are important feeding grounds for birds, as well as being of commercial importance. Where shell fish beds or estuarine areas are covered by a Several or Regulating Order, bait digging may be controlled to prevent damage to commercial species.

Farrell (1998) describes an increase in numbers of the common winkle *Littorina littorea* following bait digging in Chichester Harbour. Large flints exposed by digging provided a suitable habitat for this species which moved into the dug area.

Birds

Bird disturbance is one of the most serious impacts of bait digging in British estuaries in winter. Davidson and Rothwell (1993) review this in detail, and include a case study by Townshend and O'Connor (1993) describing the effects of disturbance by baitdiggers in the Lindisfarne National Nature Reserve. During the peak demand for bait (for the winter beach fishing season), the use of intertidal areas for bait digging coincides with the presence of internationally important populations of over-wintering and migrating wildfowl and waders. These birds need to feed continually when the tide is out in order to survive the cold winter and migrate successfully back to their breeding grounds. The presence of numerous bait diggers on the shore frequently has the effect of driving off feeding or roosting birds (Evans and Clark 1993). Bait diggers will even work shores during low water spring tides at night, when birds would also normally be feeding. Because the relationship between bird density and food availability is complex it is not known if British estuaries are at their carrying capacity for wintering wildfowl. However, it is generally accepted that a precautionary approach should be adopted when considering the impacts of disturbance and habitat loss on birds. The basis of this approach is to assume that the use of alternative sites following displacement from preferred habitat may lead to decreased food exploitation and/or increased energy expenditure, thus resulting in harmful impacts on bird populations. A review by Cayford (1993) may help to predict the effects of disturbance on the foraging efficiency, competition and dispersion of waders.

Possibly a secondary problem for bird populations is the reduction in food species caused by bait digging. The significant loss of invertebrate biomass during bait digging affects non-target species as well as the bait worms. No attempt has made to assess the significance of this reduction in abundance of food species in bait-dug areas on bird populations.

The habitat damage caused by bait-digging is also a factor affecting the feeding opportunities of birds on the shore. The basins and trenches left by hand and mechanical bait digging remain filled with water at low tide. Most birds will not use these flooded areas, tending to search for food on the exposed sand and mud flats. Bait digging therefore reduces the area available for feeding birds even when bait diggers are not present on the shore.

Monitoring has been carried out into the effect of bait diggers upon bird populations in Budle Bay, the sanctuary area of the Lindisfarne National Nature Reserve, Northumberland. Concern was initially voiced over the disturbance caused by relatively small numbers of bait diggers in this area in the early 1980s. An agreement was reached with angling groups to close Budle Bay to bait digging for two years, then to reopen a section of the area for a two year trial period and examine bird numbers in the Bay during this time. During the period of closure bird numbers and bait density increased in the Bay. When intensive bait digging (with up to 120 persons at one time) again took place in 1984 and 1985, bird numbers fell significantly. It was apparent that this disturbance was incompatible with the aims of the sanctuary area and Budle Bay was finally closed to bait diggers in 1986. Numbers of birds using the area have since risen considerably.

3.4.5 Impacts on other shore users

In many areas where there are a number of public uses of the shore, bait digging is unpopular with local authorities because of the potential conflicts with the use of public amenity beaches and the mooring or launching of vessels in the intertidal. Unfilled holes dug by bait diggers remain obvious for long periods and may be thought unsightly. Soft sediments that accumulate in these trenches are considered to be a public hazard; they may trip people walking on the beach or playing in the sea, or horse riders, causing injury. There can also be concern that digging will undermine sea walls or other coastal structures. In harbours, bait digging among small boats has been implicated in the undermining of moorings and damage to boats that become stuck in holes at low tide. Boat owners wading out to their craft may also be endangered and there are instances of fishermen and lifeboat men being unable to launch safely from the beach. Several local authorities have brought in controls on bait digging under the Public Health Acts Amendment Act 1907, Section 82, to prevent danger to the public. Some Harbour Boards also control this activity.

Bait digging can damage or destroy archaeological remains on the lower shore.

There is a potential for conflict to occur between bait diggers who may cause shore bird disturbance and bird watchers; this is most likely to occur in nature reserves.

3.4.6 Opportunities for mitigation

Most of the physical effects of bait digging, and the effects on other infauna, may easily be reduced by infilling of holes during bait digging, which is not often observed on the shore. This will hasten the process of bait stock recovery, reduce mortality of non-target species, improve habitat recovery, and minimise conflict with many of the other shore users, This practice is recommended in all voluntary codes of conduct. Improved education (particularly through tackle shops and the angling press) and wardening of bait beds might help to improve application of this code. Reducing bird disturbance, however, is more difficult to achieve because it is caused by the presence of people on the shore. Different species are influenced to varying extents by bait digging, which causes less disturbance than some other activities (some species appear not to be affected at all by baitdigging). Where a problem does exist, this may only be mitigated by reducing the source of disturbance.

Zoning of bait digging activity could be required to manage bird disturbance and to protect particularly vulnerable habitats and communities such as *Zostera* or mussel beds, saltmarsh, and particularly fragile infaunal populations. Zonation will also help to avoid conflicts between bait digging and damage to coastal structures, vessels, and other shore users who are inconvenienced or endangered by the soft holes left even after backfilling of bait holes on the shore.

Bait farming now offers opportunities for the restocking of depleted bait beds using local brood stock for many target species, but has not yet been attempted (P. Olive and P. Cowin pers. comms).

3.5. Bait pumping

3.5.1 Method

Bait pumps are mainly used for the extraction of black lugworms *Arenicola defodiens,* a relatively recently described species that appears to be confined to the lowest part of the shore on more exposed coasts, and presumably in the adjacent subtidal. The method is reportedly most successful during the low water mark of spring tides and immediately after exposure of the shore by the tide, when the sand is still very wet. A pump is placed over the newly produced lugworm faecal cast, then suction used to withdraw a thin column of sand, including the lugworm (which lies vertically in its J-shaped burrow), to the surface. This method cannot be used on all shores, but requires fairly fine, well-sorted (exposed) sands with a high water content. (Some professional bait collectors also use pumps in other habitats.) Skill is required, because it is easy to damage or break the worm using this method. In suitable conditions, however, bait pumps are quicker and easier to use than the traditional method of bait digging, and are becoming increasingly popular. They cannot be used to extract blow lug, *A. marina*, which does not usually lie vertically in its burrow or occur in such suitable sediments for pumping.

3.5.2 Impacts on bait species

These pumps are very effective at removing the target species, and for relatively little effort per worm obtained compared to traditional bait digging. This has led to anecdotal reports of bait beds being 'pumped out' after large numbers of bait collectors have been seen on a suitable shore. No study has been identified that substantiates these reports, or that indicates that pumps are more likely than traditional bait digging to deplete lugworm stocks. Black lug distribution has not been well studied, but populations appear to be widespread in suitable exposed lower shore sandy habitats, and presumably also occur in adjacent subtidal areas (where research access is difficult). If so, the species may be relatively common and only part of the population will be accessible to bait collectors during low water of spring tides. On exceptionally low spring tides (occurring on only a few days a year) most of the population could be vulnerable to collection. However, it seems unlikely that anything but extremely intensive collection efforts combined with failure of recruitment would affect the survival of any one black lug population (P. Cowin pers. comm.). Additionally, because of the scattered distribution of this species, pumping will not damage worms that are not targeted because they are undersized or have not produced a faecal cast. However, because black lug casts are not permanent, it is not easy to calculate population densities and depletion rates caused by collection, and no studies of the impacts of bait pumping have been identified. As a result, there are no published data on the impacts of collection on black lug, and its ability to recolonise from subtidal beds or nursery grounds (if any) is unknown.

Unsuccessful attempts at pumping black lug may result in the removal of their tails, or eversion of gut contents. There is no information on the survival of worms damaged in this way, but it is possible that they can regenerate these parts. Studies are required to confirm this, and to determine whether large reservoirs of unexploited black lug do occur below the low water mark, from whence they can repopulate the bait bed.

Research into the life history and exploitation of this increasingly valuable bait species would help to clarify its capacity to sustain intensive bait collection. This research is already underway as part of bait farming research efforts directed at this species, but results are confidential and unpublished. Bait farming technology also offers opportunities for the artificial rearing and restocking of depleted black lug beds following over-exploitation.

3.5.3 Impacts on other species

The use of bait pumps causes far less impact than traditional bait digging, because only a small plug of sediment is disturbed around each worm cast. Disturbance will occur to the small number of other infauna in the column of sand exposed on the surface, but not those in adjacent areas. Use of bait pumps will not bury invertebrates in spoil heaps to depths from which they cannot return to their optimum position in the sediment (personal observations). Invertebrates exposed after removal by a bait pump are also less likely to be damaged than when exposed by digging and should be better able to bury themselves again.

Disturbance to shore birds through the presence of bait pump users on the shore will be the same as caused by the presence of traditional bait diggers. However, damage to prey populations of shore birds will be much reduced for the reasons given above.

3.5.4 Impacts on habitat

Bait pumps cause insignificant habitat damage on the shore. Sediment disturbance is very much reduced compared with traditional bait digging and recovery extremely swift. Personal observations suggest that the first few incoming waves to reach the area wash away signs of pumping on exposed sandy beaches. On muddy shores, signs of the plug of anoxic sediment removed may still be visible during the next low tide in the form of discoloration at the surface (Roland Sharp).

3.5.5 Impacts on other shore users

No holes and spoil heaps are created by use of bait pumps, minimising visual impacts and inconvenience to other users. Shore bird disturbance is still a possibility, potentially causing conflict with bird watchers, but the majority of beaches used for bait pumping are relatively exposed and sandy, therefore holding fewer feeding birds than the muddy sand flats in inlets more commonly used for baitdigging.

3.5.6 Opportunities for mitigation

Any restriction on bait pumping activity, if considered necessary and if achievable under existing byelaws, would likely redirect bait collection activity back to traditional bait digging, with increased damage and disturbance to habitat and non-target species. It would not necessarily result in any significant improvements for black lugworm stocks (assuming that only a small proportion of the stock is exposed to collection activity). This is not, therefore, recommended.

Some bait collectors have suggested that temporary closure of black lug beds to bait pumping during the breeding season would help to improve recruitment rates. If this is the case, and intertidal worms do represent a significant proportion of the breeding population, this may be a way of mitigating the impacts of collection on the stocks. However, it is often difficult to advertise and promote temporary closures effectively.

Bait farming now offers opportunities for the restocking of depleted bait beds using local brood stock for many target species, but has not yet been attempted (P. Olive and P. Cowin pers. comms).

3.6. Hand picking

3.6.1 Method

Stone-turning by hand or with the use of levers at low tide is used extensively for the collection of hidden peeler and soft shell crabs (usually *Carcinus maenus*, but also small edible crabs *Cancer pagurus* and other species). Although bait collection codes promote the return of boulders to their original position in order to minimise environmental damage, a large number of collectors are unaware of the code or chose not to practice this methodology. Some commercial collectors report having to spend long hours replacing boulders to repair damage left after visits from less experienced collectors (Roland Sharp pers. comm.). In some sheltered mixed habitats, stones are also turned for the collection of ragworms (sometimes combined with bait digging, as in the Menai Straits). In those areas where rocks are not numerous on the shore (i.e. sheltered muddy estuaries) collectors place tiles onto the sediment to attract crabs for collection from these artificial sites. This activity is covered in section 3.5.

Many collectors also pick mussels *Mytilus edulis* and winkles *Littorina littorea* and occasionally a few other species from rocky shores for food or for bait.

Quigley and Frid (1998) review collecting activities (mainly for *C. maenus, C. pagurus* and *L. littorea*) upon rocky intertidal reefs in Berwickshire and North Northumberland. McKay and Fowler (1997 a and 1997 b) review collection of mussels and winkles in Scotland.

3.6.2 Impacts on target species

Despite the ubiquitous nature and abundance of the shore crabs, it is possible for heavy gathering of peelers for bait to reduce numbers locally in a popular collecting site during their moult, when breeding also takes place and they are vulnerable and quite easy to locate. Cryer *et al.* (1987) noted that replacing a boulder the right way up when searching for crab bait significantly increased the probability of finding crabs under the same boulder on subsequent tides, even when a crab was not present on the first visit. This suggests that the distribution of the population of the target species may be detrimentally affected by changes to the habitat as well as by direct removal. Collection does not take place throughout the year and recovery of populations of this common species is considered to be relatively swift.

The other bait species are not under serious threat from collection either, although their populations may be depleted. They are usually common (i.e. mussels, winkles, limpets *Patella* species and slipper limpets *Crepidula fornicata*) or only a small proportion of the population is available for exploitation, because the species mainly occurs in sublittoral areas. McKay and Fowler (1997 a) review the collection of mussels from the shore in Scotland, which is not considered to pose a significant impact on stocks. Hand collection of winkles targets the largest individuals, which are often those no longer contributing to recruitment because of infestation by flukes – in many populations it is the winkles in their first reproductive year that provide the main source of eggs and larvae. Provided that small winkles are not removed from the shore, the rate of recruitment to the population will barely be affected by collection (McKay and Fowler 1997 b)

It is possible that collectors from other ethnic backgrounds may increase collection pressures on these and other shoreline species in future for personal use. Appendix 1 lists other species that may be targeted in future.

3.6.3 Impacts on other species

Boulder turning and removal of large algae during peeler crab or winkle collection has a serious effect upon the flora and fauna of rocky shores. A rich under-boulder fauna is associated with stable boulder shore habitats. Sponges, coelenterates and ascidians encrust the undersides of rocks, with numerous other mobile invertebrates (worms, crustacea and echinoderms) sheltering here. These communities are dependent upon the shelter provided by this habitat. Seaweeds and a range of dependent fauna are found on the upper surfaces of the boulders. When boulders are overturned, the algae on the (formerly) upper side are smothered and the underboulder communities exposed to predation, wave action and desiccation. On heavily used shores, boulders are so regularly turned as to severely reduce their species diversity. Liddiard *et al.* (1989) noted that there was a marked reduction in the diversity of species recorded on rocks at disturbed sites, in comparison with undisturbed control sites.

Trampling on rocky shores also affects intertidal species composition (Brosnan and Crumrine 1994, Fletcher and Frid 1996, Quigley and Frid 1998). Foliose algal species decline and barnacles and mussels may be crushed or dislodged. Effects may arise from only small numbers of visitors to a shore, and persist for two years or more.

No research has been identified to assess the impact of removal of large quantities of shore crabs for bait on other species that may either be prey items of crabs, or whose diets include large numbers of crabs. Very heavy depletion of crab populations as a result of collection could have unforeseen ecological effects. Studies on the impact of winkles as important grazers in the intertidal were reviewed by McKay and Fowler (1997 b).

3.6.4 Impacts on habitat

The impact of boulder turning on this habitat has been examined in several studies (Bell *et al.*, 1984; Cryer, 1986; Cryer *et al.*, 1987; Liddiard *et al.*, 1989). In very heavily used areas, close to access points and centres of population, boulders may be turned repeatedly by bait collectors searching for crab. Bell *et al.* (1984) demonstrated that up to 90% of all boulders in a shore transect at Mumbles Head, Swansea, could be turned within a two week period and some boulders may be turned 40-60 times during the summer. Most boulders (60%) are not replaced in their original position. Larger boulders that are upended and not overturned completely are more likely to be left as they were found. Liddiard *et al.* (1989) suggested that a minimum of 3,000 rocks are overturned daily during periods of reasonably low tides at both Mumbles and Oxwich. An unknown proportion involves the repeated overturning of the same rocks. No 'serious' collector was seen to replace rocks in their original position, as required by codes of conduct for anglers and collectors.

Overturning boulders results in loss of habitat stability and causes significant damage, destroying underboulder, upward-facing and vertical habitats, each of which supports a distinctive community on undisturbed shores. As described above, this causes considerable damage to the species found within these habitats.

Large fucoid algae may be removed from their holdfasts to expose crabs or winkles hidden within their fronds. This results in the destruction of their understory habitats, which are important for the shelter provided to small algae and invertebrates, when the algae are washed away by the incoming tide and wave action.

3.6.5 Impacts on other shore users

Archaeological remains such as drowned field walls and fish traps may be damaged and dismantled by collectors in some areas. The appearance of the shore and its value for field studies is also affected by extensive collection.

3.6.6 Opportunities for mitigation

Promotion of a code of conduct for collection (including replacement of boulders and large algae to their original positions) will, if adhered to, reduce habitat damage and improve accessibility of crab stocks during future visits. Collection of winkles and other species may be regulated by bag limits and minimum sizes (although these regulations have not always had a successful track record in practice and require a lot of education and policing to be effective). Zonation to exclude collection from areas that are of archaeological importance, scientific importance, or used for research and monitoring may be necessary in some cases.

3.7. Provision of crab shelters

3.7.1 Method

As noted in the previous section, peeler and soft shell crabs take shelter during these vulnerable moulting stages. In areas where there are no or few natural shelters for these crabs, particularly on sediment shores and in estuaries, anglers and commercial collectors place artificial shelters on the shore to attract moulting crabs. These shelters may consist of roofing tiles, field drains, or car tyres placed onto the shore. They are either laid on top of firm sediment, or embedded at an angle into softer muddy sediments, so that the crabs can burrow underneath. They are called crab ‘shelters’ in this document because they actually operate as shelters, giving free access and egress to shore crabs. Most collectors, however, call them crab ‘traps’ even though they do not function as fishing gear by preventing the escape of the prey species.

Setting crab shelters appears to have started in the south-western estuaries, where the mild climate provides the longest season for collection of moulting crabs, but is now spreading all over the country. Very few studies have been carried out of this activity, but Godden (1995) suggested that numbers had grown from none to 8,750 traps at Plymouth, and increased 10-fold in the Exe and Teign estuaries. A few years later, the Tamar Estuaries Bait Collection Working Group (1998) gives an estimate of some 20,000 crab 'traps' within the Tamar Estuaries (Tamar, Plym, Lynher and Tavy). Of these, some 8,000 are used on a commercial basis with the 70% of the crab collected being sold elsewhere in the UK at a price of about 50 p each (suggesting that the commercial yield from this area is worth some £40,000-50,000). This estimate implies that 8,000 of these shelters actually belong to the commercial collectors who placed them on the shore and are actively using them. In reality, since these shelters are not fishing gear there is no right of ownership unless placed with the permission of the landowner and licensed by them. Any angler or commercial crab collector has the right to search for crabs under any crab shelter, natural or artificial, placed on the shore. Additionally, the landowner or leaseholder of the shore, or other competent agency (e.g. harbour authority) may remove these shelters if found to have been laid without permission.

3.7.2 Impacts on bait species

Only about 10% of the crab population is moulting at any one time, and therefore potentially vulnerable to collection (depending on whether the shelters on the shores are the main locations for moulting crab, or whether there are alternative shelters on sandbanks or in the sublittoral). The whole crab population will, however, pass through many moulting stages during its life cycle, making each individual vulnerable to collection several times. Additionally, mature females mate during the moult, so collection removes a reproductively active proportion of the population. The effect of their removal on recruitment of young to the population is unknown.

The Tamar Estuaries Working Group (1998) gives an estimate of an annual yield of 110,000 crabs within this complex of estuaries. Of these, commercial collection is thought to yield 90,000 crabs, and recreational anglers 20,000. The former figure is much higher because the commercial collectors are active most regularly, better at finding the hidden crabs, and maintain the shelters more effectively. Anecdotal evidence from anglers and collectors in the south-west suggests that recent increases in numbers and densities of shelters have not actually increased the yield of crabs from each estuary – it merely requires more shelters to be searched to provide the same number. There is, however, no information on the effect of crab collection inside estuaries using shelters on the local crab population, although shellfish farmers in the Teign Estuary report no change in the numbers of crabs on shellfish beds since large scale collection from crab shelters commenced (Philip Gibbons pers. comm.). It would be useful to undertake such studies in an estuary that is only just beginning to be exploited in this way.

3.7.3 Impacts on other species

Emplacement of crab shelters provides artificial hard substrata on shores that are predominantly sediment. This enables the settlement of species characteristic of rocky shores, artificially increasing the overall biodiversity of the area. This effect is easy to monitor. Less well understood or studied is the potential effect of placing large numbers of tiles on the natural sediment habitat and its associated species. For example, the presence of many structures may change patterns of water movement over the shore and hence sediment characteristics. Water and oxygen exchange may be reduced, fine sediments and organic material accumulate, the surface oxygenated zone become shallower, and infaunal species composition alter.

The shore crab is also a very common and important component of the shore and shallow sublittoral community. Not only does it take a wide range of prey, but it also acts as an important food source for many larger species, mainly teleost and elasmobranch fishes. The effect on prey and predators of removal of tens of thousands of adult crabs by collectors and possibly an overall decline in recruitment to the population is unknown.

Finally, the presence of large numbers of crab shelters on muddy shores means that collectors are now seen regularly in areas of soft sediment that were previously only used by feeding birds, with consequent problems of disturbance as described above as a result of bait digging in estuaries. Huggett (1995b) reports disturbance to feeding wildfowl and waders as a result of this activity.

3.7.4 Impacts on habitat

Section 3.7.3 describes how the presence of crab shelters on the shore changes the habitat by introducing hard substrata for colonisation by rocky shore species, and changes sediment characteristics by affecting water and oxygen exchange and sedimentation rates. Additionally, the presence of many collectors on the shore, particularly in muddy areas, means that previously undisturbed soft sediments are now regularly trampled by collectors, and disturbed to a depth of 20-30 cm or more.

3.7.5 Impacts on other shore users

The presence of crab shelters in very muddy sediments will only directly affect a small number of beach users: mainly individuals with moorings or shellfish beds. However, they may be seriously inconvenienced or endangered by large numbers of tiles and drains protruding 10-30 cm from the sediment. Shelters in these muddy areas are also very obvious visually, and change the appearance of the landscape considerably. Firm sediment beaches are used by a larger number of people for recreational purposes. Shelters (tiles and drains) are laid flat on the sediment in these situations, where they are not visually obtrusive and less likely to cause problems for other beach users.

Where car tyres are used as shelters, these are more likely to cause problems. They are a potential obstruction to anchoring vessels, inconvenience swimmers, walkers, and other shore users, are more visually obtrusive than tiles, and may float away if not well anchored.

3.7.6 Opportunities for mitigation

Very large numbers of crab shelters have been introduced to many south-western inlets. Despite this, there is anecdotal evidence to suggest that crab yields have not risen. It may, therefore, be possible to reduce habitat effects without detrimentally affecting collection by reducing the density and number of shelters in many areas. Laying shelters flat, rather than protruding from the sediment reduces the visual impact by making them virtually undetectable and also reduces opportunity for damage to vessels and other users. Tiles and pipes laid flat on muddy sediments do need to be moved regularly to prevent them from becoming covered by sediment. Zonation could be used to reduce bird disturbance caused by collectors visiting shelters, and conflicts in mooring and navigation channels or in shellfish beds covered by Several or Regulating Orders.

3.8 Bait dragging

3.8.1 Methods

Ragworms may be collected from very soft muddy sediment (usually unsuitable for digging) by dragging rakes behind a boat when the tide is in. Dyrynda (1995) has carried out a one-day study of bait dragging in Poole Harbour on the south coast, which appears to be the only UK location where this activity is undertaken. This may be due to the long high tide stands in the harbour, which make it possible for dragging to be undertaken for long periods. No more than

15 professional boats and about the same number of casual fishermen are involved, taking large numbers for the retail bait trade. The gear used is a large double-tined drag, with tines of about 0.3 to 0.4 m long, towed through the mud behind a boat in order to hook and drag out large worms. These worms, and some other large invertebrates, gather in a ball on the tines of the drag. The activity takes place on the lower shore and in the shallow sublittoral, both on accessible shores and on remote and isolated mudflats, leaving behind circular scars on the mudflats that may be visible from the air (Dyrynda 1995).

3.8.2 Impacts on bait species

The drags are very effective collectors of king ragworm *Nereis virens*, but quite a large proportion are injured during dragging (up to 50% on occasions in shelly ground). Some of the damaged worms are discarded over the side of the boat. Other worms are likely to be damaged during dragging, but not brought to the surface. Survival of damaged worms may be quite high (they are capable of regeneration) if they are not predated before being able to rebury themselves. Dyrynda (1995) notes that evidence suggests that intensive bait dragging does cause local stock depletion, but that there are no convincing indications of a large-scale decline in stocks across the harbour as a result of this practice. Substantial stock depletion would result in the activity becoming uneconomic, providing a certain amount of self-regulation.

3.8.3 Impacts on other species

The effect of bait dragging is not considered to be significant for small surface-dwelling or infaunal invertebrates. However, large burrowing invertebrates are more likely to be damaged by the large tines. Species and communities considered by Dyrynda (1995) to be particularly vulnerable include softshell clams *Mya* spp., peacock worm *Sabella pavonina* beds, seagrasses *Zostera marina* beds, saltmarsh (although it seems unlikely that dragging would take place in this habitat), and commercial mussel *Mytilus edulis* beds. The peacock worm and seagrass beds are of high marine nature conservation importance. Dragging may break up mussel beds, and the mussels may be driven into the underlying ‘mussel mud’ to a depth from which recovery and survival is unlikely. Dyrynda and Lewis (1994) note the concerns of nature conservation bodies over the potential effects of disturbance and changes in prey community structure that may be caused by bait dragging and digging on bird populations.

3.8.4 Impacts on habitat

Dyrynda’s 1995 study carried out intensive dragging during 2.5 hours over a small area of only 0.02 hectares. Surprisingly, this affected only about 10-30% of the surface area. However, the scars caused were very conspicuous in places, consisting of furrows up to 10-20 cm wide flooded with water and showing black anoxic subsurface sediment. Most of the physical disturbance was sub-surface, covering a much larger area where the sediment had been disturbed and softened by the buried tines of the drag. Fine sediment is released during dragging, causing turbidity in the water column until it is redeposited elsewhere. Some cockles were unearthed, but undamaged, burrowing anemones disturbed, and significant quantities of dead shell exposed. Otherwise, no significant differences in sediment composition were detected. However, it is important to note that this activity takes place in some of the most remote and undisturbed areas of the harbour, which would otherwise be almost completely undisturbed by man. The activity also overlaps with areas affected by bait digging, potentially leaving virtually no undisturbed refuge areas within the harbour.

3.8.5 Impacts on other shore users

The visual effects of bait dragging are only rarely visible from the shore, meaning that the aesthetic effect of this activity on the appearance of the harbour mudflats is limited. The activity is a cause for concern to mussel fishermen, who relay spat in the harbour for on-growing. Bait dragging is not permitted on leased mussel grounds, but may occur there accidentally or otherwise (mussel beds are thought to harbour particularly large stocks of king ragworms). The activity is also of concern within nature reserves, because of potential impacts on natural habitats and vulnerable species, possibly including bird populations. Bait dragging is also discouraged in the vicinity of the main navigational channels, mooring areas and navigational and berthing installations.

3.8.6 Opportunities for mitigation

If any change is considered desirable to the current informal voluntary arrangements through which the small numbers of bait draggers restrict their activities, a more formal zonation of this activity might be the best means of minimising impacts on other shore and seabed users. However, because there appears to be no means of regulating the activity under current legislation, this may be difficult to achieve.

3.9. Worm dredging

Mechanical lugworm dredgers have been in use in the western part of the Dutch Wadden Sea since about 1975, when four machines were harvesting about 17-20 million lugworms per year. This, combined with 12-16 million dug by hand, represents about 0.75% of the total population of lugworm in the area (Wolff *et al*. 1981). The first experimental dredging in Britain took place in Essex in 1989, but commercial exploitation of lugworm beds in the UK has not been undertaken. This is because the cost of the licence that would be necessary for the redeposition of dredged sediment under the Food and Environment Protection Act 1985 (FEPA) was so high as to make this activity uneconomic.

3.9.1 Methods

Mechanical dredges work at high tide. A barge is anchored over the sand flats on a 250-300 m cable. The barge is very slowly winched towards the anchor and a gully 1 m wide and 40 cm deep is scooped out by the dredge. The sediment is sieved with jets of water through a 1 cm mesh and lugworms removed by hand from the material retained on a conveyor belt inside the barge. Several gullies can be worked on each tide.

3.9.2 Impacts on bait species

Dredging causes the complete removal of all lugworms in the dredge tracks (Heiligenberg 1987), but dredges usually only operate within a very large area of intertidal sand flat, and are likely to leave considerable areas untouched. Beukema's (1995) study of a 1 km^2 area found that near doubling of annual lugworm mortality rate occurred, resulting in a gradual and substantial decline of local lugworm stock from more than twice the overall mean at the start of the four year digging period.

3.9.3 Impacts on other species

This activity removes a very large amount of the invertebrate biomass, in comparison with hand digging. Heiligenberg (1987) examined the effects of both hand and mechanical digging in the Dutch Wadden Sea. Hand digging (reviewed above) caused a significant reduction in many of the common species, including *Scoloplos armiger*, *Nereis diversicolor*, *Heteromastus* and, of course, *Arenicola* (50% removal). A total of 1.9 g of other benthic animals were removed for every 1g of *Arenicola*. Mechanical digging has a much more serious effect, with complete removal of *Arenicola* and up to an 80 or 90% loss of the Baltic tellin *Macoma baltica*, *Scoloplos* and *Heteromastus*. Using this method, for every gram of lugworm taken, 9 to 13.4 g of other invertebrates are removed from the area. Beukema (1995) found that recovery of the benthos took several years, mainly because of the slow re-establishment of a soft shell clam *Mya arenaria* population with a normal size and age structure.

The impact on feeding birds of the introduction of mechanical bait dredging requires consideration. Bird disturbance at low water should not be an important factor, if the dredging barges are left unattended at this time. On the other hand, this activity removes a very large amount of the invertebrate biomass, in comparison with hand digging, and the habitat damage will reduce the feeding areas available to shore birds.

3.9.4 Impacts on habitat

Mechanical dredging for lugworm has a similar effect on the sediment habitat as that caused by hand digging. Dredging in the Wadden Sea, where the dredged sediment is strained through a sieve with water jets, leaves gullies 40 cm deep and one metre wide, bordered on each side by a 1.5 metre wide ridge a few cm high (Heiligenberg, 1987). This is similar to, but more severe an effect than caused by a hand-dug trench with no back filling. Fines are released, and any contaminants in the sediments also become available for uptake by marine organisms. Monitoring of the fauna of dredged sites in the Netherlands was carried out for six months, suggesting that the relief of the sediment surface may have enabled relocation of the dredged areas throughout this time (the author does not record the rate of physical recovery of the sediment surface over that period). Dredged tracks in Essex (pers. obs, 1989) tend to fill with water and accumulate seaweed, as seen for bait-dug holes, and previously buried shell rejected from the sieves is scattered over the surface. The area of effect can be greater than occurs during normal levels of bait digging.

Hugget (1992) notes that a dredger can make three 250 m x 1 m trenches per tide, and working just once a day could damage at least ½ hectare of mudflats per week. Working a 5-day week for 30 weeks of the year, a single dredger might mobilise and redeposit 90,000 tons of sediment per year.

3.9.5 Impacts on other beach users

Most likely to be affected if the dredge tracks interfere with recreational activities, commercial fisheries, or archaeological sites.

3.9.6 Opportunities for mitigation

There appear to be few means of mitigating the effect of this activity, which is not currently underway in the UK. It will be important to ensure that any future applications to undertake such operations are licensed appropriately and excluded from sensitive areas.

When a proposal was made in the 1980s to introduce bait dredging to inlets in south-east England, there was considerable concern over the potential impacts of this activity. The (indirect) regulating mechanism used in this case was the Food and Environment Protection Act 1985 (FEPA). Because the sediment would be raised above the surface of the sea before being re-deposited on the seabed, an appropriate fee was required before a FEPA dumping licence could be issued by MAFF. This made the proposed operation uneconomic. Alteration of the sieving technique used might make this means of control inappropriate.

Fishing operations do not require a FEPA license. Thus, a fishing vessel dredging for bivalves, but also taking bait worms as a utilised bycatch, would fall outside the scope of this form of control.

3.10. Bait farming and imports

It is estimated that sea angling activity in the UK currently uses at least 1,000 tonnes of bait worms *per annum*. It is impossible to quantify this trade, because so little of it is recorded or declared, but market surveys indicate that some 500-700 tonnes of bait worms are dug for personal use and 300-500 tonnes of worms from commercial (including 'black economy') sources enter the retail trade. Bait worms entering the retail trade are derived from wild-dug and farmed sources in the UK and elsewhere in Europe. The value of this industry is high. Table 7 presents the commercial value of the main bait species in the UK, which figures suggest that the UK bait market is worth between £25 and £30 million *per annum* (including mollusca and crustacea). King ragworm *Nereis virens* represents at least £8 million of this total. This is comparable with the baitworm market in other parts of the world. The commercial bait digging industry in Maine, USA (see Appendix II) produces about 200 tonnes of baitworms a year for domestic use and export to several countries, and Japan imports about 600 tonnes a year of bait worms a year from around the world.

Table 7. Commercial value of common angling bait species

Bait species	**Price paid to collector* by shop**	**Price paid to shop by angler**
Peeler crab *Carcinus maenus*	20-25p/crab (casual collector) 35-40p (professional collector)	50-55p per crab (occasionally 35p) 70p per crab for Devon peelers
Black lug *Arenicola defodiens*	80p to £1.80 per 10 gutted and packed worms	£2.20-£3.80 per pack of 10 gutted worms; £12/lb in South Wales (number/lb varies)
Blow lug *Arenicola marina*	£8-£10 per 100 worms	£2.20 per pack of 20 worms
Ragworm *Nereis virens* (farmed)	£8 + VAT/lb, farmed bait from Holland.	£2.5-£2.75 per quarter pound (incl. VAT).

* Higher prices are paid to the professional collectors, who supply shops regularly, than to casual bait collectors. Prices vary considerably around the country according to local availability and season. So much bait goes through unreported trade that prices paid to collectors varies considerably and accurate figures are very difficult to obtain.

There is, naturally, considerable commercial interest in increasing supplies of farmed bait worms for the retail trade. Currently, retail demand for bait greatly outweighs supply, particularly at times of year when weather and tide conditions make bait collection difficult, wild stocks are at naturally low levels, and demand for certain target angling species is high. Farmed bait, currently mainly comprised of the king ragworm *Nereis virens*, but soon to include lugworms *Arenicola marina* and/or *A. defodiens*, could potentially supply virtually all of this demand. The environmental benefits that may be gained from increased bait farming and a reduction in bait digging activity are considerable. Many anglers state that they would prefer to purchase cultured bait rather than dig their own, if supplies were of high quality, reliably available, and reduced the environmental impact of angling activity.

It was estimated in 1985/86 that the retail trade in England and Wales sold some 140 to 150 tonnes of king ragworm *N. virens* per year (about 37 million worms, worth up to £5 million at prices of about 12-15p per worm, Cowin (pers. comm.)). The numbers of lugworm (*Arenicola* spp.) supplied (at about 10p each ten years ago) will have greatly exceeded this. These worms were obtained mainly from wild sources in south coast harbours, Northern Ireland, and the Netherlands. By the end of 1998, the annual retail turnover in bait worms (from farmed and wild-dug sources) was thought to be in the range of 300-400 tonnes (Tony Smith pers. comm.). Existing bait farms are unable to meet this demand.

Two main existing suppliers of farmed bait were identified in the UK. The larger of these is Seabait Ltd., set up in 1986 on a power station site in Northeast England (where warm water supplies were available), to produce the king ragworm *N. virens*. This is the most suitable species for farming: fast growing, a popular bait, and easy to breed in artificial conditions. Seabait produced in excess of one million six inch worms (five tonnes) from this site in 1989, at a retail value of £2.25 per 80g pack (containing 16 worms), or £28 per kilogram. This production rose to about 30 tonnes a year in the late 1990s, with a retail value of £750,000. Seabait is now starting production through a licensee in Ireland, and anticipates production of 37 tonnes next year from both its sites, including some production of lugworm. The UK market requires worms of 6-9 inches long, or 5-8 g weight, which take 6-8 months to grow. Seabait also exports to the Mediterranean where the market prefers one to two inch worms as bait for the very small seafish commonly caught in Southern Mediterranean countries, and these can be produced in about three months.

A new king ragworm *N. virens* farming site is currently being established in the UK, and plans to open in 1999 under franchise from Topsy Bait of the Netherlands. This site plans an initial turnover of 75 tonnes in its first year, increasing to 300 tonnes after 3-4 years of operation. It will be capable to rearing ragworms to saleable size in just two months. Topsy Bait currently exports from the Netherlands to nine countries, and is unable to meet demand from its present site.

Of the other widely used bait worms, the lugworms *Arenicola marina* and *A. defodiens* have a more complicated life cycle than *N. virens* and are more difficult to cultivate (the more valuable and larger black lug *A. defodiens* may be more suitable than *A. marina*). Research into introducing these species into cultivation is now well advanced and Seabait will be selling *Arenicola* in 1999. Breeding of white ragworms *Nephtys* species is also difficult to achieve. Research is nevertheless underway to attempt to culture white ragworms and peeler crabs for the retail market. With the use of artificial hormones to induce moulting, it should be possible for a continual supply of peeler crabs to be provided.

Developments in the culture of bait species provide important potential for the artificial restocking of depleted bait beds using locally-caught brood stock. Seabait has expressed a strong interest in becoming involved in the sustainable management of bait stocks in this way.

A number of non-native polychaete species may have life cycles and growth rates which make them more suitable candidates for farming than *Arenicola marina* and other native bait worms. The commercial returns from introducing such species to the bait market in Britain could be very large, but the probability of introductions to the wild would be high, either through discharge of farm tank effluents or the use of live worms for bait. Such introductions would be in breach of the Wildlife and Countryside Act (1981) (without a licence). Developments in the culture of non-native species should be monitored very carefully, and actively discouraged.

In addition to the possible introduction of non-native species as farmed bait, wild-caught worm species are already being imported to Europe for use as bait and could potentially become established in the wild as a result (see Table 8). For example, the bloodworm *Glycera dibranchiata* is imported to France from the USA (Maine) and huge quantities of an unknown number of polychaete species are imported from wild stocks in China, Korea and Taiwan (where some bait is farmed) to European countries, where imported baits are preferred (Peter Olive, pers. comm.).

These imported baits are not yet been used to any great extent in the UK, and it would be advisable to ensure that this situation continued. There is a long history of introductions of non-native species to UK waters, and the impacts of some of these introductions are now well understood. They include competitive displacement or predation of native species, alteration of natural habitats, and damage to fisheries. Additionally, the introduction of valuable non-native species may result in the initiation of collection activity targeting these species in areas that were formerly undisturbed. Large predatory polychaete worms would be a particularly undesirable addition to the UK marine fauna, and their establishment in the relatively warm water of south coast harbours and estuaries is of particular concern.

Wholesalers, retailers and anglers should be informed of the dangers of introducing non-native species to the marine environment through using live baits (which survive falling off the hook or being discarded at the end of a fishing trip) and the legislation that prohibits the release of such species.

Table 8. Main commercial Polychaete bait species (wild stocks) (from Olive 1994).

Family	Species	Production origin	Destination
PHYLLODOCIDA			
Nereidae	*Nereis virens*	UK	UK
		USA (Maine)	USA (CA, FL), France
		Ireland	UK, France, Italy, Spain
		Netherlands	UK, France, Italy, Spain
	Nereis diversicolor		
	Perinereis cultrifera	Italy	Italy
	Perinereis nuntia	China	Japan
	Perinereis brevicirrus	Korea	Japan, USA, Europe
Glyceridae	*Glycera dibranchiata*	USA (Maine)	USA (Gulf & West coast states)
Nephtyidae	*Nephtys hombergi*	UK	
EUNICIDA			
Eunicidae	*Marphysa sanguinea*	Korea	Japan, Europe, USA
		Italy & Portugal	Southern Europe
	Marphysa leidyi	Australia	
Onuphyidae	*Onuphis teres*	Australia	
Lumbrinereidae	*Lumbrinereis cf impatiens*	Italy	
ARENICOLIDA			
Arenicolidae	*Arenicola marina*	UK, Netherlands, France & Ireland	Europe
(From Olive 1994, citing personal observations, private market surveys, Creaser *et al*. 1983, Choi 1985, & Gambi *et al*. 1994.)			

Acknowledgements: Peter Cowin and Peter Cadman, Seabait UK; Tony Smith, Topsy Baits; and Peter Olive, University of Newcastle, generously contributed their knowledge to this section.

3.11 Conclusions and gaps in knowledge

In many cases shoreline species collection activity is not thought to be incompatible with nature conservation objectives in marine sites. Some scientific and site management case studies, however, demonstrate that habitat damage and alteration, damage to non-target species, and bird disturbance and prey depletion may arise from this activity, particularly if carried out on a large scale. These are summarised below. In such situations, shoreline species collection (whether for bait or for food) may require mitigating action if intertidal nature conservation objectives are not to be compromised.

3.11.1 Habitat damage

Literature review indicates that habitat damage on sediment shores is likely to be most serious in low energy environments, where sediments are poorly sorted (mixtures of stones and mud), often polluted, and recovery rates from bait digging can be very slow. Such sites are frequently located in estuarine areas and other inlets, close to centres of population, exposed to heavy use by collectors, and also subject to many other development pressures.

More wave exposed, sandy shores are not as significantly affected by bait digging, and the use of bait pumps in these locations appears to cause negligible damage. Very large-scale use by mechanical bait dredgers has the potential to cause significant damage even in these situations.

Some studies of boulder turning for peeler crabs have demonstrated that serious habitat damage, particularly on sheltered, stable boulder shores, can occur when boulders are not replaced. The effects of wide-scale introduction of crab shelters in estuaries on habitats and species have not been studied, but are considered likely to be significant in some areas. Investigations are required of the impacts of introduction of crab shelters into inlets on the sediment habitats occupied by large numbers of shelters, bird populations, and crab populations. In particular, the optimum density of crab shelters, both for minimising habitat effects and maximising yields should be determined as a matter of urgency. Shelter density is probably unnecessarily high in some areas. The effect of the orientation of shelters (flat versus driven at an angle into the sediment) should also be examined. Much of this work might be undertaken, at least initially, through undergraduate projects.

3.11.2 Impacts on bait species

Most populations of bait species are not threatened by collection, even locally. Many of the animals used by anglers are common and widely distributed, with their life cycles and ecology enabling a quick recovery from low population levels. Exceptions to this rule are the catworms *Nephtys* species and unusual long-lived king ragworm *Nereis virens* populations like that studied in the Menai Strait. Heavy bait digging pressures may seriously affect the survival of local populations of these groups.

In the case of the Menai king ragworm, a single unique population could be endangered without the controls on this activity planned within the proposed Marine Nature Reserve. Studies of other reported populations of unusually large king rag worms *Nereis virens* (e.g. in Milford Haven) are needed to determine whether these also have the characteristics of those in the Menai Strait, and whether management of these stocks are necessary. This could be a useful undergraduate project, modelled on those carried out in the Menai Strait.

There is very little information available on the impacts of collection of large numbers of peeler and softshell crab *Carcinus maenus*, and potential means of mitigating these. Undergraduate projects could compare population structure in exploited and unexploited areas and estuaries.

More information is required on the biology, ecology, and exploitation of the valuable bait species, the black lugworm *Arenicola defodiens*, including survival after tail loss and eversion of internal organs. Would closure of beds during breeding periods result in increased levels of recruitment, and in which habitats do the larvae live? This information would help to determine the impacts of bait collection on this species (presently considered to be relatively small) and establish appropriate bait collection management regimes, if necessary. Some life cycle information is apparently already known, but commercially confidential and unpublished. Field studies might be undertaken as undergraduate projects, and more detailed research as a postgraduate study.

Not much is known about the biology of white ragworms *Nephtys* species and potential for mitigation of the impacts of collection of this genus. Research into captive populations might provide some useful information (some is likely already known, albeit unpublished and in confidence), as well as determining the potential scope for restocking depleted bait beds of this and other species by breeding local brood stock in bait farms.

3.11.3 Impacts on non-target species

The non-target invertebrates most affected by bait collection are large, long-lived, slow-growing infaunal species that may be fragile, easily damaged by bait diggers and slow to recolonise areas. Under-boulder fauna, which are dependent upon a stable and very specialised habitat, are also severely affected by boulder-turning by collectors in search of peeler crab. Diverse communities characteristic of some poorly-sorted sheltered sediments may also be damaged by bait collection or the introduction of crab shelters. Mechanical bait dredging causes a high loss of biomass in areas dredged.

Disturbance of feeding shore birds caused by the presence of bait collectors on the shore at low water in some sensitive areas is a very serious problem. The removal of invertebrate biomass (bird food) is also potentially significant, particularly if mechanical dredging takes place. Most methods of bait collection (probably excluding bait pumping) may cause significant habitat and non-target species damage, and all may restrict the areas of shore available to feeding birds.

3.11.4 Impacts on other shore users

Bait collection activity can incompatible with certain fisheries - mainly through damage to intertidal cockle and mussel beds, or increased access difficulties to shellfish beds.

Habitat damage and alteration may also be incompatible with some recreational uses, harbour operations and archaeological heritage. Problems caused include deterioration in the aesthetic appearance of dug shores and crab shelters, human safety, and physical damage to vessels and structures.

Competition between different groups of bait collectors (anglers *vs*. commercial collectors, ‘professional’ *vs*. ‘unemployed’ commercial collectors, and/or locals *vs*. visiting collectors) has sometimes been reported when over-exploitation of bait stocks takes place. It can be extremely difficult to resolve such competition through voluntary agreement or self-regulation where visitors are involved, and because of the difficulty of proving a distinction between commercial and non-commercial activity. Many bait collectors are in favour of a system for licensing bait diggers (requiring commercial collection and sales to be recorded), which should be backed by resources to implement and enforce licensing agreements.

3.11.5 Other impacts

One issue not covered above is the impact of changing coastal structures on sediment transport on the shore, by siltation of rocky shores or baitworm beds, habitat loss and change, and loss of bait stocks. This was a concern raised by several anglers and commercial collectors, but is outside the scope of this project.

3.11.6 Mitigation

Mitigation of these effects, other than as indicated in the preceding sections, is possible to some extent through existing codes of conduct for bait collection, although unfortunately these are sometimes ignored by a significant number of collectors. Bag limits have been attempted, with limited success, to reduce effort and hence environmental impacts. In a few cases, zonation of incompatible activities has been introduced, either under voluntary agreement or backed by legislation. A number of examples of management to mitigate the impact of shoreline species collection are presented in Appendix II (Case studies).

Artificial culture using local brood stock may prove to be an important means of promoting the recovery of over-exploited stocks.

Several individuals consulted during the preparation of this report expressed a wish for a licensing or permit system to be introduced for the regulation of commercial bait collection and resale, similar to that in place in Maine (see case study in Appendix II). Such a system would require retail outlets to record the license details of all bait collectors from whom bait was purchased, and the quantities, species and origins of the bait. The benefit of such a system would be the protection of bait stocks for anglers and professional bait collectors from unregistered, unemployed bait diggers. (The latter are thought to be the source of much of the damage to bait beds.) Licensing would also offer improved potential for the assessment and regulation of commercial collection within the area, and the promotion to anglers of codes of conduct for bait collection.

Chapter 4. The legal framework

4.1 Introduction

This section presents the main conclusions drawn from the legislative review carried out during the preparation of these guidelines. It is, however, stressed that the legal status of worm collection for bait, which is not directly regulated under existing legislation, is in need of legislative review. No legal expert was involved in producing this section. A future legislative review might draw different conclusions, and judicial review is required to clarify several of the issues highlighted here.

This review identifies the general features of the legal framework. There is no single common framework across the UK and, whilst there may be strong similarities in their effect, the legal position in different parts of the UK have evolved from different beginnings. This review is not able to address these variations comprehensively. Furthermore, the review should be seen as guidance to legislation and current opinion on the legal status and management of bait collection and not as a definitive account of the legal position. Therefore readers are strongly recommended to seek expert advice in connection with any bait or shellfish collecting issues.

This review drew on studies presented in Cleator and Irvine (1995), Fowler (1992), Huggett (1995a and 1995b who provided valuable reviews of legal issues with regard to activities on the shore), and important recent case law. An unpublished information paper by Andrews (1998) clarified the legal situation with regard to ‘sea fish’ (crustacea and mollusca).

The recent case law on bait digging comprised two significant rulings:

- the decision made regarding the collection of intertidal and subtidal species from Strangford Lough (**Adair v. The National Trust** 1997, judgement of Girvan J.), and
- the Court of Appeal ruling over **Anderson v. Alnwick District Council** (1992), concerning a conviction under a local authority byelaw controlling baitdigging that went to appeal at the Crown Court and Court of Appeal.

It is recommended that readers refer to the original case law on the above two judgements if they need more information than is briefly summarised in this report or the case studies in Annex II, or wish to quote any part of this case law.

To date, a range of statutory bodies have used their legal powers to manage or regulate bait worm collection (Table 9). Examples of the legislation under which bait collection may be regulated, and the statutory bodies that may exercise these powers, are listed in Table 10.

Further information setting out the wider legal context to the legislation relating to collection of bait and animals is provided in Appendix IV. This Appendix covers the definition of the foreshore, ownership and common law rights over the foreshore, customary rights and tolerances.

4.2 Summary of findings

4.2.1 The public right to collect bait and shellfish

The collection of intertidal ‘sea fish’ (fish, molluscs and crustaceans) is a public right – an integral part of the inalienable right to fish in tidal waters, and is open to everybody. This right is usually extended to allow the public to collect shellfish (molluscs and crustaceans) from the exposed foreshore, provided that they have a right of access to the shore. The public right to fish may be regulated under byelaw, but not extinguished. Exceptions are where these rights have been transferred to the owner of the shore (usually by pre-Magna Carta grant in England) or severed from the public fishery by Several Order (see below).

The public right to collect bait worms is ancillary to the public right to fish and is limited to personal use only (Anderson v. Alnwick District Council). There is no legal right to take worms commercially without the permission of the landowner. An exception may occur where private rights over certain areas of the shore exist, either by grant from a landowner or by local custom following extremely long and continuous use of an area by a clearly identifiable group of people. Such customary rights are rare and very difficult to prove. In practice, it is extremely difficult to differentiate between personal and commercial bait collectors on the ground, making this legal distinction unhelpful.

In Scotland, mussels and oysters were removed from the public fishery by The Mussels Fisheries (Scotland) Act 1847 and The Oyster Fisheries (Scotland) Act 1840. These species now belong to the Crown and rights to fish commercially for them are managed by the Crown Estate Commissioners through issuing licenses. In many areas the Crown has ceded title to these fisheries to local landowners or communities, although no public record of these titles is readily available and even the Crown Estate does not have clear records (McKay and Fowler 1997a). The Acts which removed mussels and oysters from the public fishery pre-date the judgement of Hall v. Whillis which supported the concept of the right to collect naturally occurring shellfish or other bait species (including mussels) by hand, provided that there is access to the shore and the end use is non-commercial. This suggests that the collection of mussels for bait or ‘for the pot’ in Scotland is a tolerance of the Crown.

4.2.2 Regulation of fisheries (seafish and shellfish)

‘Sea fish’ are species that are made subject to fisheries legislation. This definition includes only fish, crustacea (including peeler and soft shell crabs) and molluscs (including mussels and winkles). There is a public right to collect these species for commercial sale and for personal use from public sea fisheries throughout the UK, subject to legislative controls. Sea fish may be used for bait or for food (their end use is irrelevant in legal terms). The right to fish for these species may be controlled or regulated by fisheries legislation. Fisheries bylaws may not extinguish the public right to take ‘seafish’, they only regulate it (and thereby seek to protect the public right by ensuring that the resource is not destroyed). Regulating fishing rights in this way, whether by closed seasons, minimum landing sizes, quotas, closed areas or other measures, does not require the regulating body to compensate fishermen for any loss of catches or other costs imposed by the introduction of such measures. This is because all commercial, recreational, full time and part time fishermen are treated equally.

4.2.3 Regulation of bait worm collection

The collection of other species other than ‘sea fish’ (worms are the most important in the UK, but echinoderms and tunicates could be included), including the public right to dig bait worms for personal use as an ancillary to the right to fish, is not directly governed by any statute. This right can, however, be regulated indirectly (although not extinguished completely) by a variety of Local Authority, public health, nature conservation, Fisheries and Harbour Authority byelaws (see Table 10). Such byelaw provisions may extend below the mean low water mark to all parts of the shore uncovered by the tide at any stage, but may take two to three years to be drafted, approved and implemented. The bylaw-making authority needs to demonstrate that the controls are expedient (Huggett 1995a) and that fishermen are still able to gather their bait from other nearby areas.

The collection of ‘non-sea fish’ other than for personal use for bait is not part of the public right to fish. It requires the permission of the landowner, which may (in theory) stop this activity on their foreshore. In practice, and depending on circumstances, such action may be impracticable.

4.2.4 Several and Regulating Orders

The right to collect named species of molluscan shellfish and crustacea may be assigned exclusively to named individuals, companies, organisations, or local communities under a Several Order. This completely removes (or 'severs') the public right to fish for (a) named species in a certain area for the purpose of developing the fishery. Additionally, Section 7 (Protection of fisheries) of the Sea Fisheries (Shellfish) Act 1967 establishes a system for protecting the named shellfish from harm, such as may potentially be caused by disturbance of the shore during the collection of species not named in the Several Order. Bait digging, stone turning or the installation of crab tiles may, therefore, potentially be controlled under Section 7(4)(e) within an area covered by a Several Order. In this way, Several Orders may indirectly bring opportunities for management measures that are of benefit to the conservation of biodiversity as well as the fishery concerned, for example by regulating bait digging activity which would be equally detrimental to e.g. cockle stocks as to wildlife and habitats.

In Scotland, Several Orders provide, *inter alia*, the principal tool for bringing management of shellfisheries more directly under the control of local communities (A. Downie pers. comm.).

A Regulating Order allows a wider range of controls to be made to regulate a public fishery. The fishery remains a public fishery, but the Order generally requires a license to be obtained by all individuals wishing to fish. Licenses may be granted to every applicant, laying out the conditions under which fishing is permitted (e.g. using specified methods or setting quotas), or more usually only to a limited number of fishermen, thus managing fishing effort. The protection afforded by section 7(4)(e) of the Sea Fisheries (Shellfish) Act 1967 does not apply to Regulating Orders. This form of Order is usually granted to public bodies (i.e. Sea Fisheries Committees in England and Wales, Local Authorities, or any other suitable body or consortia of organisations (e.g. a consortium in Shetland including the local authority, fishermen's association, Scottish Natural Heritage and others).

4.2.5 Landowners' rights

The rights of foreshore owners with regard to the collection of shoreline species are complex, and have still not fully been tested under case law. The 'natural products' found on the seashore belong to the owner of the shore, but not the 'sea fish' found there. The public may exercise common law rights (bait collection for personal use and collection of 'sea fish') over the foreshore without landowners' permission. Exceptions occur where there are ancient proprietary rights associated with the ownership of coastal land over, e.g., adjacent shellfisheries (this most commonly occurs in estuaries or other inlets) or where fisheries are private as a result of a pre-Magna Carta grant in England.

Landowners may issue licenses or permits for individuals to take 'natural products', including commercial baitworm digging. This could encourage landowners to manage bait stocks sustainably to generate revenue, but their inability to regulate the activities of potentially large numbers of individuals collecting for their own use, or to distinguish effectively between commercial and personal collection may limit the success of this approach.

It is difficult in practical terms for many landowners to exert control over the damaging activities of 'third parties' (those who are not owners or occupiers) on intertidal SSSIs, e.g. commercial bait diggers, as legally required of landowners under Section 28(5) of the Wildlife and Countryside Act 1981. The Department of the Environment, Transport and Regions (DETR 1998 b) suggested some options for tackling this problem, including enabling conservation agencies a *locus* for involvement. These include: creating a specific offence (deliberately or recklessly causing damage) with appropriate penalties; using byelaws to prevent damage; and improving liaison between conservation agencies and Police Wildlife Liaison Officers. (The alternative approach is use of a Section 29 Nature Conservation Order – see Budle Bay case study.)

4.2.6 Structures on the shore

The legal right of individuals to install 'structures' on the shore to provide shelter for peeler and softshell crab and increase the effectiveness of collection is unclear. The right to fish on the foreshore without landowners' permission includes the right to place fishing gear there. Fishing gear must entrap 'seafish', which crab shelters do not – they simply provide habitat. The deposition of these structures may be covered by the Food and Environment Protection Act 1985.

In some estuaries, landowners have removed crab shelters, because they were installed without permission, or have demanded 'rent' for installation and operation in specified areas. These actions have 'solved' local problems by moving activity to other areas.

Anyone may in theory remove crabs from shelters, unless they have been placed under a private agreement with the landowner, which may give them a legal status. This is however likely to be contended by crab collectors. Furthermore, the legal rights for individuals to remove crabs from structures that are not actually fishing gear, but are licensed to other individuals by the landowner, is a 'grey area' and would benefit from judicial review.

4.2.7 Legislation and Byelaw-making powers

The Department of Environment, Transport and Regions (DETR 1998 a) provides a guide to the implementation of the Habitats Directive in European Marine Sites (SACs and SPAs) in Great Britain. This outlines the important powers, duties and functions of competent and relevant authorities under the Habitats Regulations. Competent authorities include any statutory body or public office exercising legislative powers on land or at sea. Relevant authorities are those of the competent authorities with local powers or functions that have, or could have, an impact on the marine area within or adjacent to a European marine site, and powers to establish a management scheme for such a site. Table 9 lists the competent authorities exercising legislative powers in the intertidal zone, and the restrictions on their powers with regards to the regulation of bait collection.

Table 10 lists those statutory mechanisms under which competent authorities may control baitdigging by byelaw or other regulation (this is not a comprehensive list).

Table 9. Competent authorities, regulatory powers of potential relevance to bait collection activity, and restrictions on applying these (from DETR 1998 a).

Competent Authority	Regulatory Powers	Restrictions
Nature Conservation Agencies	• To make byelaws to protect MNRs. • To regulate or prohibit activities within NNRs, including access and movement and killing or removing flora and fauna. • If no other competent authority is responsible for controlling damaging activities within Special Areas of Conservation or Special Protection Areas under the Habitats Regulations, this will fall within the remit of the agencies.	• May not regulate fisheries where a regulatory authority already exists. • May make byelaws for nature conservation purposes only. • May only control damaging activities within SACs or SPAs if no other competent authority exists.
Local Authorities (County Councils, District Councils or Unitary Authorities in England and Wales; Councils in Scotland)	• To prevent damage, obstruction or annoyance to persons using the seashore. • To regulate and prohibit activities for the good rule and government of a district. • To regulate and prohibit activities within country parks, to prevent damage to land and to avoid undue interference with the enjoyment of the land. • To regulate or prohibit activities within National Parks, AONBs, and areas covered by access agreements to preserve order, prevent damage to land, and prevent undue interference with the enjoyment of land.	• Cannot be used to prohibit activities completely, or to protect the environment. • Cannot be used where other powers exist, or to protect the environment.
Environment Agency	• Powers of a Sea Fisheries Committee (see below) where none exists. In England and Wales only.	• As above.
Port and Harbour Authorities	• To make byelaws for the proper regulation of the harbour. • In some cases this may include fishing, use of foreshore, and nature conservation.	• Powers may not usually be used to protect the environment.
Sea Fisheries Committee	• To regulate and prohibit fishing for sea fish from high water out to 6 nautical miles from baseline (England and Wales only). • May regulate fisheries for environmental purposes under the Environment Act 1995. • Required to exercise its functions under the Sea Fisheries (Wildlife Conservation) Act 1992 so as to secure compliance with the requirements of the Habitats Directive.	• Cannot regulate fisheries for non-fisheries purposes. • Cannot affect private rights. • Sea fish do not include bait worms.

Table 10. Statutory mechanisms and regulating authorities for the management of bait collection

Legislation	Statutory Authority & purpose of legislation	Examples of bait collection controls (mainly from Fowler 1992)
Civic Government (Scotland) Act 1982	• Enforced by the Scottish Executive Rural Affairs Department (SERAD) and Local Authorities. • Enables Councils to make byelaws for the purpose of preventing nuisance or danger at, or preserving or improving the amenity of the seashore, and for conserving the natural beauty of the seashore by regulating the exercise of sporting and recreational activities. • Competent authorities with functions under S. 120 to 122 of this Act (control of the seashore and adjacent waters) must exercise these so as to secure compliance with the requirements of the Habitats Directive (DETR 1998).	• Three authorities in Fife (Dunfermline, Kirkcaldy and North East Fife) co-operated in drafting byelaws to govern the seashore and adjacent waters for the above purposes under this Act. These appear to provide a means of preventing baitdigging in specified areas. It is unknown whether any Council has attempted to use their byelaws for this purpose.
Conservation (Natural Habitats etc.) Regulations 1994	• Transpose the requirements of the Habitats Directive into national law and provide for the conservation of SACs and SPAs in Great Britain. Regulations 22-24 allow for 'special nature conservation orders' to be made.	• None yet enacted. However, if (as seems likely) no other competent authority is responsible for controlling this activity, it will fall within the remit of the nature conservation agencies.
Control of Pollution Act 1974	• Competent authorities with functions under Part II of this Act must exercise these so as to secure compliance with the requirements of the Habitats Directive (DETR 1998).	
Countryside Act 1968	• One of the enactments under which compliance with Habitats Directive requirements will be secured. Section 15 applies to sites of Special Scientific Interest. (DETR 1998)	
Countryside (Scotland) Act 1967 and 1981	• Enforced by the Scottish Executive Rural Affairs Department (SERAD), Scottish Natural Heritage, and Local Authorities. • Regulates and prohibits activities in country parks, to prevent damage to land and to avoid undue interference with enjoyment of land. • One of the enactments under which compliance with the requirements of the Habitats Directive will be secured (specifically Section 49A which covers management agreements) (DETR 1998).	• East Lothian Council regulates the uses of John Muir Country Park (baitdigging for private, non-commercial use permitted) and Aberlady LNR (all baitdigging prohibited). • Commercial baitdigging has been prohibited in the Montrose Basin LNR. Baitdigging for personal use is permitted in a specified area of the Reserve. • North East Fife Council controls baitdigging in the Eden Estuary LNR (enforced only for commercial activity).
Environment Act 1995	• Major statute repealing and amending much previous environmental legislation. • Environment Agency for England and Wales is required to 'protect and enhance the environment'. Has powers of a Sea Fisheries Committee where none exists. • Scottish Environment Protection Agency has, *inter alia*, pollution control functions.	
Environmental Protection Act 1990	• Requires 'statutory nuisances' to be dealt with by local authorities. One of the enactments under which compliance with the requirements of Sections 131 to 134 of the Habitats Directive will be secured (DETR 1998).	
Food and Environment Protection Act 1985	• MAFF and SERAD issue licences to dump below the high water mark.	• Might cover installation of crab shelters (fishing gear is exempt).

Table 10 continued

Legislation	Statutory Authority & purpose	Examples of bait collection controls
Dockyard Ports Regulation Act 1865	• Competent authorities with functions under this Act must exercise these so as to secure compliance with the requirements of the Habitats Directive (DETR 1998).	
Habitats Directive/Habitats Regulations : see Conservation (Natural Habitats etc.) Regulations 1994 (above)		
Harbours Act 1964	• Statutory powers are conferred on Harbour Authorities by local legislation. Harbour Acts are specific to each authority and vary considerably, depending upon local circumstances and commercial and other activities in the Harbour area. • The obligation of the ports industry to the environment is included within its statutory powers, but these powers are tied to their primary statutory function - administering ports and coastal waters within their jurisdiction for use by commercial vessels. Even though the 1992 Transport Act (see below) gave environmental powers and duties to Ports and Harbour Authorities, their existing Harbour Acts and byelaw making powers do not enable them to take any action for the protection of the environment. Most Harbour Act byelaws control baitdigging in order to ensure that it does not interfere with commercial activities (e.g. navigation, anchoring, and safety of structures or vessels). • Competent authorities with functions under this Act must exercise these so as to secure compliance with the requirements of the Habitats Directive (DETR 1998). This may mean applying for new powers by means of an order under the Harbours Act 1964.	• Chichester Harbour Conservancy byelaws (prohibit baitdigging within 50 feet of any mooring or 20 ft of any structure). • Fowey Harbour Order Act (1937) and Fowey Harbour Byelaws (1996) enable the Commissioners to prohibit bait digging from areas of moorings and slipways, and the laying of crab traps in areas where they pose an obstruction to anchoring or navigation. • Langstone Harbour Board byelaw (1984) prohibits baitdigging within 3 m of moorings and 10 m of slipways or jetties. • Penzance Harbour Byelaws (1980) prohibit digging outside designated areas, to prevent direct or indirect damage to boats and moorings. • Port of Sunderland Dock Estate byelaw prohibits baitdigging in the Dock Estate. • Scarborough Harbour Act (1843), has a clause preventing baitdigging within the Harbour area in the interests of safety. • Torbay Borough Council's Tor Bay Harbour Byelaws control baitdigging activity in Torquay Inner Harbour, Brixham Harbour and Paignton Harbour.
Local Government Act 1972	• Section 235 provides local authorities with powers to enact byelaws for good rule and government and suppression of nuisances.	• Cannot be used where more specific legislation is available.
Military Lands Act 1900	• Competent authorities with functions under Section 2(2) (provisions as to use of sea, tidal water or shore) must exercise these so as to secure compliance with the requirements of the Habitats Directive (DETR 1998).	
National Parks and Access to the Countryside Act 1949, Sections 20 and 106	• Local authorities have powers to make byelaws for local nature reserves under Section 20. • Section 20(2)(b) enables byelaws to be made that prohibit or restrict the killing, taking, molesting or disturbance of living creatures of any description in a nature reserve. • Section 101(8) provides that such byelaws apply to Crown land if the Crown Estate Commissioners consent. • Part III of this Act is identified by DETR (1998) as one of the enactments under which compliance with the requirements of the Habitats Directive will be secured.	• Very few local authorities use their nature reserve byelaws to control baitdigging, at least partly due to cost and anticipated enforcement difficulties. • Teignbridge DC does not use it to prohibit baitdigging in the Dawlish Warren LNR. • Kent County Council uses byelaws to control baitdigging and collection of other intertidal organisms in part of the Swale LNR by issuing permits. (Havard and Tindall 1991 report that very few bait diggers here hold a licence.) • The Pembrokeshire Coast National Park byelaws potentially affect all Crown foreshore in Dyfed (National Park foreshore), but have not been enforced and used to control baitdigging.

Table 10 continued

Legislation	Statutory Authority & purpose	Examples of bait collection controls
National Trust Act 1907, National Trust Act (Northern Ireland) 1946, National Trust Act 1971, Section 24	• Enable byelaws which, *inter alia*, may: • a) prohibit any person without lawful authority from digging ... sand, clay, or other substance; • e) prohibit injury of any building, structure or other thing; • n) generally prohibit or regulate any act or thing tending to injure of disfigure the land ... or to interfere with the use and enjoyment thereof by the public. • Byelaws may prevent taking, molesting, wilfully disturbing, injuring or destroying wildlife, provided that 'nothing in or done under any of the provisions of the foregoing byelaws shall in any respect prejudice or injuriously affect the rights of any person'...	• An attempted prosecution of three bait diggers in Newton Haven, Northumberland, September 1985 was unsuccessful. • The National Trust (Northern Ireland) has tried, unsuccessfully, to use its byelaws to prevent individuals from collecting shellfish and digging bait over the entire foreshore owned by the Trust in Strangford Lough. The Judgement by Girvan in Adair v The National Trust was that there was a common law right for species collection from the foreshore and bed of the Lough. • The Trust is currently reviewing its powers.
Public Health Acts (Amendment) Act 1907, Section 82	• These generally ensure public safety, maintain the appearance of beaches for amenity purposes, or safeguard harbour walls, slipways and boat moorings. • Local Authorities may enact byelaws 'for the prevention of danger, obstruction or annoyance to persons using the seashore.' • Some byelaws under this act make provision for digging permits to be made available, either for locals only, or at certain times of the year, in specified areas or conditional upon back-filling of holes. • It is unclear whether it is necessary for the land to be owned or leased by the Local Authority for this power to be applied. Section 82 does not mention any such constraints, and Section 94, which applies to navigation on the sea, clearly enables local authorities to regulate activities within areas that are neither owned or leased. • Fowler (1992) noted that there was much inconsistency in approach to the use of this legislation reported, with some authorities being unable to obtain clearance for byelaws which had been approved in other districts.	• Alnwick District Council regulates baitdigging to prevent problems when launching boats: 'without lawful right or authority no person shall in any part of the restricted area dig for ragworms or for any form of fishing bait'. • Caradon DC regulates baitdigging at Torpoint, where moored vessels had been damaged, and hazards caused to the public by holes left in the shore). • Eastleigh DC (controls at Netley since 1978 due to concern over hazards of bait dug holes to the general public). • Maldon District Council (in respect of a Several Fishery area – granted prior to the Magna Carta – to prevent damage to foreshore and injury to public as a result of commercial baitdigging). • Lancaster City Council proposed a byelaw (for foreshore owned at Morecambe and Heysham). • Other authorities considering introducing such byelaws have been discouraged likely difficulties and enforcement costs (e.g. at Filey Beach, North Yorkshire).
Sea Fisheries Regulation Act, 1966	• Sea Fisheries Committees (SFC) enact regulatory byelaws within their Districts in England and Wales under this Act. • These may prevent baitdigging where it would conflict with other fishing activities.	
Sea Fisheries (Shellfish) Act, 1967	• Provides powers to establish Several or Regulating Orders. • Several Orders give exclusive rights to an individual or company to take named species of shellfish within a defined area, and may protect shellfish from harm caused by other activities (e.g. bait collection). • Regulating Orders enable a Local Authority or other suitable body to regulate a fishery, usually by licensing fishermen.	• A South Wales Sea Fisheries Committee byelaw limits areas open to baitdigging to protect access to the Burry Inlet cockle fishery and cockle stocks. • Several SFCs protect mussel beds from baitdigging and other forms of disturbance by byelaw. • Enforced in Scotland by the Scottish Executive Rural Affairs Department (SERAD).

Table 10 continued

Legislation	Statutory Authority & purpose	Examples of bait collection controls
Sea Fisheries (Wildlife Conservation) Act 1992	• Gives Sea Fisheries Committees nature conservation duties that must be used to secure compliance with the requirements of the Habitats Directive (DETR 1998).	
Transport and Works Act 1992	• Amendment of Schedule 2 of the Harbours Act 1964 by the Transport and Works Act 1992 enables harbour authorities to seek harbour revision orders for the conservation of fauna and flora, if 'the appropriate Minister is satisfied that the making of the order is desirable in the interests of ... the management of the harbour in an efficient and economical manner'.	• These new provisions had not yet been used several years after enactment (DoE 1996). Expecting every harbour authority independently to seek revisions of their own harbour orders is obviously be a time-consuming and inefficient way to progress. DETR is currently considering giving environmental powers to all ports in under a single Act.
Wildlife and Countryside Act 1981	• Part I and Sections 28 to 28 are identified by DETR (1998) as one of the enactments under which compliance with the requirements of the Habitats Directive will be secured. • Section 29 enables byelaws and Nature Conservation Orders to be made for the management of Marine Nature Reserves and National Nature Reserves, although such byelaws are only rarely enforced. • Competent authorities with functions under Sections 36 and 37 of this Act (Marine Nature Reserves) must exercise these in European Marine Sites so as to secure compliance with the requirements of the Habitats Directive, provided that this does not interfere with or override the exercise of the functions of any other relevant authority (DETR 1998).	• 'The removal of any fauna for use of bait, whether by digging, bait pump, or any other means' is prohibited under Section 29 within part of the Lindisfarne National Nature Reserve. (A Public Inquiry held in 1994 found that proposed changes to the byelaws and Nature Conservation Order were expedient and necessary.) • Regulation 36 of the Conservation (Natural Habitats etc.) Regulations (1994) requires the statutory conservation agencies to use Section 37 byelaw-making powers if there is no other relevant authority or the relevant authority is unable to act for legal or practical reasons.
Miscellaneous Local Authority Acts		
The Humberside Act (1982)	• Provides Cleethorpes Borough Council with powers to control 'digging for or removal of sand, bait *etc.* from the seashore'. It re-enacts a similar control in the Cleethorpes Improvement Act (1902).	• Fowler (1992) reports that about 140 individuals are licensed to dig for bait in a designated area at one end of an amenity beach. There had been about 20 prosecutions for illegal baitdigging under the Act. The Borough Council was asked to relax this control in order to allow baitdiggers to take bait from the restricted area, because the designated digging area was hard to dig over. The Council was advised not to change this policy because it would have resulted in the restricted area of beach becoming similarly damaged by extensive bait digging (Olive, pers. comm.).
The Southend-on-Sea Corporation Act (1895)	• Enables the Borough of Southend-on-Sea to limit baitdigging to areas seaward of a quarter mile limit from the seawall and certain hardways beyond this distance. The byelaw was enacted because of the public nuisance and potential danger caused by holes left by baitdiggers.	• Numerous successful prosecutions had been made and an injunction obtained against one persistent offender, who was reportedly imprisoned (Fowler 1992).
Isle of Wight County Council Act (1980)	• Enables District Councils to control baitdigging under byelaw.	

4.3 Conclusions

There is generally a public right to collect seafish (including crabs and molluscs, but not worms) from the shore. This public right may be severed under a Several Order, which confers the right of fishery to one body for the purpose of developing the fishery, or regulated under various fisheries byelaws (all species of sea fish, including molluscs and peeler crabs, are made subject to fisheries legislation). In practice, resources will limit the extent to which the targeted exploitation of additional ‘sea fish’ (e.g. shore crab *Carcinus maenus*) may be brought under control.

Marine bait worms are not seafish, but certain rules still apply to their collection. Collection for personal use is permitted, but collection for commercial sale is illegal unless approved by the landowner or (extremely rarely) under certain other, exceptional, circumstances where private rights apply. Because it is very difficult to prove conclusively during collection which end use is intended, this distinction is of very limited practical use when seeking to regulate commercial collection activity on the shore.

The most significant legal constraint on the management of bait worm collection is that this activity is not directly regulated by present legislation, although it may be regulated for public safety reasons or to protect wildlife or shellfisheries.

New legislation would be required to bring marine worms into the public sea fishery and to extend the remit of fisheries authorities to cover the management of all worm stocks and fisheries, regardless of end use. Measures used could then include the seasonal closure of worm beds and harvesting activities, imposition of bag limits, and even the complete closure of the worm ‘fishery’ in certain areas. The resources available for the licensing, policing and enforcement of existing fisheries legislation are already limited, making the introduction of additional licensing, policing and enforcement responsibilities for fisheries authorities difficult to achieve under current conditions. Enforcement costs also limit the effectiveness of other existing regulatory mechanisms.

The inability of relevant authorities to pass discriminatory byelaws, e.g. limiting the numbers of bait collection licenses issued, is a major obstacle to effective, sustainable management of bait collection activity. Many anglers and commercial collectors have voiced support for the introduction of a local licensing scheme to regulate the scale of bait worm and peeler crab collection activity whether for commercial or personal collection (the equivalent to licensing numbers of fishers within an area covered by Regulating Order). There is currently no means of achieving this other than on a voluntary basis.

There is generally reluctance for central government departments to approve the introduction of any new byelaws, because these create criminal offences and impose an additional burden on regulators. Voluntary or ‘self-regulating’ solutions for the resolution of management difficulties are always the preferred means of procedure. These voluntary solutions are not, however, always effective in practice.

There could, in future, be circumstances that make it desirable to extinguish completely the unregulated public right to fish, including bait collection, within a specified area. Such a course should only be considered if the conflicting requirements of various user groups and environmental impacts in the area under consideration are unacceptably high, have not been able to be resolved in any other way, and there are no alternative bait beds nearby. However, since new primary legislation would be required to extinguish the public right to fish and collect bait, this is not a practical consideration for coastal site managers.

Chapter 5. Management options

5.1 Introduction

This chapter draws on a review of the legal framework, summarised in the previous chapter, and a series of case studies (described in Appendix II) that examined examples of shoreline species collection management in the UK and overseas. The major management options for minimising the impacts of shoreline species collection on nature conservation features that were identified through these reviews and their advantages and disadvantages are briefly summarised in Table 11. Table 12 provides a slightly different perspective, by matching collection activities with the potential management options available. More detailed information on each possible management options, their effectiveness, and the potential management problems associated with implementing them appears in the following sections.

Many of the case studies examined and summarised in Appendix II illustrate attempts to address management issues after species collection had been identified as a serious cause for concern, sometimes unsuccessfully or effective only after some false starts. One of the best examples of management (Maine, USA) relies on a legislative framework not available in the UK. It must be stressed, however, that although many of the case studies refer to management problems, these are mostly isolated examples that have affected only a very small number of sites. In the vast majority of UK sites, species collection is either not an issue or is already 'managed' effectively, if informally, through voluntary agreement or code of practice. By their very nature, such examples of good management practice are not usually well known (no problem: no publicity).

Where attempts to resolve conflicts between species collection and other interests have had a poor track record, whether through use of codes of conduct, bag limits, conditional licensing schemes, or zonation of activities, the case studies indicate that this is usually due to one of the following factors:

- Difficulty in communicating with the collectors, because they are neither part of the local community, nor members of a readily identifiable national or regional group. Saunders *et al*. (1998) indicate that only 10-25% of all sea anglers are members of the National Federation of Sea Anglers or National Federation of Anglers and their member organisations.
- A lack of resources put into education, policing, and, where necessary, enforcement locally and on site.

It is very important that these factors are considered and addressed in all cases where management of shoreline species collection activity is considered desirable (regardless of the management option selected) if a successful outcome is to be achieved.

When considering management options for managing shoreline species collection (particularly for bait), it is useful to consider the types of individuals that are likely to be undertaking this activity and how they may be consulted over proposals and/or informed of management measures in place. These are listed below in very broad categories (note that these definitions only illustrate extremes along a spectrum of activity and that many commercial collectors also take bait for personal use).

- Commercial collectors, who regularly use and 'manage' the same area of local shore in order to provide regular supplies of bait to retail outlets. These individuals are usually identifiable, and may be encouraged to form a local 'user group' for the discussion of bait collection issues.

- Experienced bait collectors, based in the area, who collect for personal use, are part of a local users group, and/or members of one of the existing national or regional angling organisations.
- Inexperienced, local or visiting bait collectors, who only take bait a few times a year for personal use, are inexperienced (inefficient or careless) or unconcerned with the sustainability of marine resources, may live a long way from the area, and do not belong to a user group or organisation.
- Commercial collectors, whether local or visiting the area, who may have taken up commercial bait digging for a short period only, be inexperienced and inefficient, and/or have no concern for local bait stocks.

This range of user groups will pose constraints on the effectiveness of several of the available management options. Implementation of voluntary codes or agreements by the last two groups listed above is likely to be most difficult to achieve. Where visiting anglers take bait, or collectors travel long distances to bait beds, it is extremely difficult to contact them through local education or interpretation initiatives. A national campaign, utilising tackle shops and angling press would be more helpful. Additionally, it is possible that a few bait collectors are simply not concerned with local environmental issues.

Unsuccessful attempts to use either voluntary forms of agreement or complex compromise arrangements for regulating incompatible activities have in the past tended to escalate towards the most straightforward method of control: simple exclusion of all collectors from problem areas. This draconian solution has the merit of being easy to understand, and relatively easy to police and enforce on site. It does, however, have serious limitations, including the diversion of collection effort to other unmanaged areas, potentially leading to more serious problems elsewhere, and very expensive legal fees if challenged by collectors in court. As such, it should only be considered as a solution of last resort.

Enforcement of legal controls on shoreline species collection has sometimes been hampered by the rather cloudy legal position of the public right to collect shoreline species (see Chapter 4). There is also an overall unwillingness on the part of authorities to resort to the expense of a prosecution (and subsequent appeals) to test the law. Recent judgements in case law have still not fully resolved the legal position.

Table 11. Options for managing intertidal species collection activity

Management option	**Advantages**	**Disadvantages**
National code of conduct for bait collection	• Primarily intended to influence the conduct of collection activities, e.g. by voluntary agreement on methodology of collection and informal bag limits. Potentially an extremely important and valuable means of bait collection regulation. • Should reduce conflicts with other users. • May improve yields. • May be self-regulating. • Already promoted by several user groups.	• Must be supported by resources and personnel for education and promotion, on and off-site, particularly for those who are not members of national user groups.
Local/regional code of conduct	• Potentially an important and valuable means of bait collection regulation. As above, aims may include reducing conflicts (by changing methodology or zoning activity), and improving quality and quantity of stocks. • User groups already promote several such codes, often within an estuary management plan or SAC forum. • May be self-regulating.	• Difficult to implement if some collectors are not members of recognised user groups participating in the local management forum, or are based outside the area. • Requires significant resource input for on and off-site education and promotion.
Participation of collectors in local management plans	• The management plan process for MNRs, Estuaries, SACs or other areas provides an unmatched opportunity for discussing and resolving apparent or actual conflicts between intertidal species collection and other coastal uses. It may promote sound management, through any of the techniques listed here.	• Resources required for long-term commitment to participation in the plan.

Continued on next page…

Table 11 continued

Prohibition or licensing of commercial bait collection activities	• Commercial bait collection is a potential source of conflict among bait collectors and between collectors and other users. It is not part of the public right to fish, but widely tolerated and provides an important source of bait for many anglers. • Commercial bait collection may be licensed formally by landowners (who may not, however, regulate competing non-commercial collection activities). A very few collectors have rights to collect bait commercially in specified areas.	• Extremely difficult to enforce ban because of the difficulty of proving commercial collection in court. • Loss of commercial supplies and rising retail bait prices may result in increased recreational bait collection activity and conflict with other users in many locations (collectors may supply retail outlets over a very large area).
Bag limits	• Intended to conserve stocks and reduce impacts by limiting activity, particularly commercial collection. • Generally acceptable to recreational collectors.	• Very difficult to enforce, even with resources for education and policing. • May increase collection effort.
Licensing	• No discrimination is possible; all applicants must be issued with licences and conditions applied equally. • The application licencing process ensures that all licence holders are informed of management issues and requirements.	• Successful implementation requires significant resources for education, administration and enforcement.
Zonation	• May be voluntary or backed by legislation. Could consist of: • permanent exclusion zones (to protect core areas of reserves, recreational beach quality, coastal structures, commercial or recreational shipping infrastructure *etc.*) or • temporary, rotational zonation. The latter is likely to be more acceptable to anglers (because larger quantities of target species may be collected as areas are rotated).	• Permanent exclusion is more effective because easily understood and cheaper to administer and manage. • Rotational zonation is more difficult to enforce and will not protect habitats, coastal structures, or long-lived species.
Closed seasons	• May prevent damage to bait stocks or other wildlife at vulnerable periods, such as breeding or migrating seasons.	• Peak bait demand occurs during lugworm breeding and bird migration/ overwintering season.
Closure of bait beds	• If voluntary agreements fail, complete prohibition of collection at a site is easier for managers to administer and enforce than any other management option. • Closure must not completely stop bait collection in an area, but ensure that alternative sources remain accessible.	• Closure of a bait collection site will increase pressure on stocks and may cause conflicts at sites up to 100 miles away. Requires careful assessment of the effects of closure before introduction.
Improving retail sources of bait	• Increasing quantities of bait are now available through retail suppliers derived from farmed stocks of native species. • Imports of native bait species take place from Ireland and the Netherlands. Such imports are of great importance for angling and if good quality should reduce pressure on local stocks, but should be from sustainably managed stocks.	• Imports of non-native species (e.g. from Japan or Korea) are illegal and must actively be discouraged among retailers. • Import of unmanaged, unsustainable commercially dug worm stocks from other areas is undesirable.
Fisheries legislation	• Most shellfish already fall under the remit of Sea Fisheries Committees/MAFF and Scottish Office Agriculture, Environment and Fisheries Department (SERAD). • Other species may be added. • Fisheries legislation and byelaws are a well-established means of controlling fisheries activities, with Fisheries Officers responsible for policing and enforcement.	• Limited resources for fisheries management will make enforcement of regulations for non-commercial collection or addition of new species to statutes an extremely low priority.

Table 12. Impacts and management options

Activity	Impacts	Management options
Crab collection	• Damage to habitat and non-target species, including bird disturbance. • Safety problems and other conflicts to shore and water users. • Stock depletion unlikely to be serious, but potential impact on commercial stocks by removing undersize specimens.	• Educational programme (through tackle shops and angling press) to promote code of conduct for boulder turning. • Voluntary agreements for regulation of crab shelter numbers and locations. • Options for control under Sea Fisheries byelaws include permanent or rotational closure of areas to collection, Several or Regulating Orders, bag limits, and licensing of collectors. • Minimum sizes apply for some species. Could be extended to others.
Mollusc collection	• Damage to habitats and species. • Some populations of long-lived and slow-reproducing molluscs may be of nature conservation importance. • Collection may conflict with commercial fisheries, where not controlled by Several Order. • Digging may cause amenity or safety problems for other shore users.	• Educational programme to promote code of conduct for bag limits, minimum sizes, and/or zonation of activity. • Razor fish collection for commercial gain prohibited by local authority lease-holder in south-west Wales. • Options for control under Sea Fisheries byelaws may include permanent or rotational closure of areas to collection, controls on gear used, Several or Regulating Orders, bag limits, minimum sizes, and licensing of collectors.
Bait digging	• Potential conflict with nature conservation (non-target species and habitat damage). • May conflict with fisheries operations. • May cause damage to vessels and coastal structures. • May be incompatible with some amenity uses and harbour operations.	• Codes of conduct, promoted through tackle shops and angling press. • Voluntary agreements with recreational and commercial users. • Regulating extent of baitdigging (through permanent, seasonal or temporary zonation, licences, and/or bag limits). • Prohibition or regulation of commercial bait digging only. • As a last resort, prohibition of bait digging by one of a number of nature conservation agency, fisheries, local authority and harbour authority byelaws, where the activity impinges on these organisations' responsibilities. • (Bait digging is unregulated by legislation targeted at this activity.)

5.2 Voluntary codes of conduct

National and regional sea angling bodies and most, if not all, local clubs strongly promote a sea anglers' code that includes guidelines for protecting the marine environment and mitigating harmful impacts. These codes include measures as simple and effective as avoiding moorings and other intertidal structures while digging bait and back-filling the holes and trenches produced, returning rocks and weed to their original positions when collecting crabs and shellfish, and only taking the minimum bait required for planned fishing trips. They are potentially extremely valuable in minimising many of the impacts of bait collection and interactions with other users, particularly those arising from damage to habitats and non-target species. They not only conserve bait stocks, but may even increase yields.

Another advantage of this approach is that intertidal species collection (particularly for bait) is undertaken sufficiently regularly by a large number of individuals that fairly effective self-policing and self-education of the activity should be achievable. The lack of awareness of any bait collection activity or problems resulting from this among coastal managers in many regions certainly suggests that these codes of conduct are working effectively in some areas.

Unfortunately, evidence obtained from consultations, field visits and examination of well-known bait collection case studies demonstrates that, in practice, only a minimum of bait collectors actually adheres to most of the guidelines set out in these codes in many areas. It is rare to see bait diggers back-filling holes, and most individuals searching for crabs do not replace rocks and stones. The two main reasons that so many bait collectors are seen to disregard these codes of conduct are probably:

- The small proportion of all sea anglers who belong to one of the governing bodies. The majority may not even be aware of the existence of national or regional codes of conduct and their importance for conserving stocks and maintaining access to collection sites.
- The reportedly large numbers of unemployed persons seeking additional income through commercial bait collection. They are probably neither anglers nor professional bait diggers, and are more concerned with short-term monetary rewards than environmental issues and long-term management of bait stocks.

This is unfortunate. Codes of conduct so obviously protect the interests of the bait collectors that it should be possible to gain much greater support for their promotion and benefit from a degree of self-education and policing among users. (A history of conflicts – sometimes physical – within and between foreshore user groups does, however, indicate that encouraging any degree of self-enforcement of voluntary or statutory controls by collectors is extremely unwise.)

Some of these problems could be resolved by improvement in the resources and personnel available for education and promotion of these codes, both on and off site. A targeted national education and conservation programme with assistance from angling publishers and gear manufacturers would be most effective in reaching the majority of anglers who are not members of the governing bodies.

Dealing with the problem of the unemployed, casual commercial bait collectors is more difficult. Most professional bait collectors and many retail outlets are in favour of the introduction of a licensing system similar to that operated in Maine, USA (see Appendix II). This would require all origins, purchases and sales of bait to be registered and reported by bait collectors and wholesale and retail bait outlets. Such a system would provide a means of promoting good practice among all commercial collectors, but is probably outside the competence of SAC management groups to implement, even locally.

The Budle Bay experimental study of the effects of bait digging (summarised in Appendix II) received a great deal of input from the National Anglers Council (NAC) and Northern Federation of Sea Anglers Society (NFSAS). These organisations promoted and circulated widely an agreement setting out a code of good practice for bait digging in the Nature Reserve, including zoning areas open to baitdigging, back-filling holes, and excluding the use of lights. The case study demonstrates that it is possible to increase the degree of compliance with a voluntary code of conduct through discussion, consultation, and considerable educational efforts.

Unfortunately, compliance with the code only appeared to be short-lived and limited in this particular case (Langton 1994). This was despite the efforts of the NFSAS to ensure that most anglers digging on the site were aware that conforming to good practice was essential if access to the bait beds was to be continued, and the policing of the agreement by Nature Conservancy Council staff. It must be noted that this unsatisfactory outcome was influenced by exceptional circumstances in the region, including the large quantities of commercial bait digging underway for part of the time, which could not be influenced by the input of the governing bodies for recreational angling. Additionally, a major issue at the site was bird disturbance by individuals present on the shore, which could not easily be resolved by the code.

The conclusion from this exceptional case is that codes of conduct, in theory an excellent idea, may fail when bait collection pressures intensify or if there is a lack of resources for effective promotion and education. They are, in practice, more likely to be effective if backed by continual reinforcement and policing on site, and preferably supported by additional incentives. An example of the latter is one of the conditions of the bait digging licences issued by Kent County Council to all applicants for bait digging in the Swale Nature Reserve: that holes should be back-filled. If enforced on site, non-compliance of this condition would lead to removal of the licence.

Finally, as noted above, it may simply be that the successful examples of regulation through codes of conduct simply do not attract attention because they do not raise coastal managers' concerns.

5.3 Participation in local management initiatives

Assessments of case studies that have resulted in the successful mitigation of harmful effects of user activities or conflicts (excluding shoreline species collection, for which there are very few examples of successful best practice) virtually always highlight the importance of community participation and support for the management initiatives. Such consensus can only be achieved following detailed consultation and discussion of the management proposals. This community participation is of virtually equal importance whether the management is wholly voluntary or backed by legal measures. However, as noted in the previous section, it is subject to the same constraints as the national codes of conduct for bait collection – the difficulties not only of contacting all regular users of the shore, but particularly those users who are only visiting the area. Advertising through local tackle shops and bait outlets is likely to be the best means of publicising such initiatives.

It is unrealistic to assume that this type of community involvement does not require as many resources, at least initially, as needed for the imposition, management and enforcement of legal controls. Setting up an effective local management initiative is expensive and may take many years, including periods of review, reassessment and changes to management until an acceptable and satisfactory regime is achieved. In the much longer term, however, this approach is likely to result in a much greater degree of compliance and effectiveness (and ultimately lower costs) than simply by enacting legal regulation in the absence of consultation and consensus and having to resort to very expensive prosecutions to enforce this.

With regard to the collection of shoreline species, any of the management techniques listed here that are applied following public consultation are more likely to receive consensus. Given the extensive experience of coastal managers developing estuary management plans, Shoreline Management Plans and marine SAC management plans, it is not considered necessary to cover the process of community involvement in detail here.

The most recent case studies, for example regulating the placement of crab shelters to aid with the collection of peeler and soft shell crabs in south-western estuaries, are still developing and it is too early to determine how well they will succeed. They do, however, look promising, not least because of the way in which commercial and recreational crab collectors have become organised into identifiable user groups that are undertaking discussions with local site managers and are able to police their own group's activities on the shore.

5.4 Bag limits

Bag limits or quotas are frequently used for the conservation of natural resources and can be very successful if backed by adequate education and enforcement. They may also reduce impacts by limiting damaging activities associated with harvesting, particularly those undertaken by commercial collectors. Bag limits for intertidal species are very likely to be acceptable to recreational collectors, and will reduce commercial collection activity by making this less economically viable.

However, bag limits for small organisms such as bait species are very difficult to enforce, even if resources are available for education and regular inspection and policing on site. Experience from the case study of bait digging in the Burry Inlet described in Appendix II demonstrates that the lugworm bag limits briefly enacted here are very easy to circumvent (bait diggers simply buried excess numbers if Fisheries Officers were seen to be approaching). Additionally, preventing commercial bait digging through the imposition of bag limits is likely to result in an increase in numbers of bait diggers on the shore. The new bait diggers will be individuals who are no longer able to obtain commercial supplies and therefore driven to digging for their own bait, likely in a less effective and more damaging manner.

Successful introduction and enforcement of bag limits for shoreline species may therefore actually lead to increased numbers of bait diggers, larger areas of shore being dug less effectively, increased levels of damage to habitats and non-target species, and increased conflict with other users. The New South Wales case study (Appendix II) demonstrates that even the successful imposition of low bag limits can be ineffective in preventing depletion of resources if the numbers of collectors active at a site is very large.

5.5 Licensing

Under current UK legislation, it is not possible to apply discrimination when licensing fishing activities – all individuals must be treated equally, and anyone wishing to apply for a licence must be entitled to do so. For this reason, it is not possible to restrict the numbers of individuals collecting species within any area by permitting only a limited number of local residents or members of an organisation to collect.

Conditions may, however, be attached to licences, imposing restrictions on techniques used (e.g. back-filling of holes), bag limits, closed areas, closed seasons, declaration of catches *etc*. Such licence conditions (including any of the management techniques listed here) must be applied equally and may not actually prevent all bait collection in any one area. The process of applying for and issuing licences enables managers to ensure that all licence holders are informed of current local management issues and requirements. Licence holders infringing these conditions may have their permits rescinded. A certain amount of self-policing by the user group would be possible, if only by ensuring that all bait diggers at a site were aware that a licence was necessary and available.

The owners of the foreshore may license commercial bait diggers, or the placement of crab shelters by any individuals. It is not clear whether holding a licence to a crab shelter provides the licence holder with exclusive rights to take crabs from the shelter, in cases where the landowner has not been able to transfer their own private right to take shellfish to the licensee.

Successful implementation of a shoreline species licensing system requires provision of significant resources for education, administration and enforcement. Licence fees permitted by the relevant government department or indeed desirable to promote compliance will not be sufficient to recover these costs, but similar costs would probably be incurred if other management options are selected.

There is likely to be resistance to the introduction of a limited licensing system for bait collection, were such an approach possible (and this seems unlikely under the current legal system). Criticism of this approach usually includes the potential for abuse of the system because the licences may increase rapidly in value if transferable.

As already noted above, many professional bait collectors and retail outlets are in favour of the introduction of a formal nation-wide licensing system similar to that operated in Maine, USA (see Appendix II). Bait collectors would only be permitted to sell to wholesale or retail outlets on production of their licenses. Records of license number, and quantities, origins and types of bait bought and sold would have to be maintained by retail outlets and wholesalers – incidentally making this information available to the social security offices. This would benefit professional bait collectors by putting them on an even footing with the unemployed collectors, who presently have the advantage of working within the ‘black economy’. It would yield small but significant income through licenses and increased reporting of taxable income. Finally, it would benefit the environment, by providing funds for research from license fees, by increasing control over currently unregulated commercial collection activity, and by providing a means of promoting good practice among all commercial collectors.

The introduction of a national licensing system of this sort would probably require new legislation. Introducing a similar system locally, albeit not as comprehensive, may be within the competence of some SAC management groups in those situations where licenses for commercial collection can be issued by foreshore owners or lease-holders.

5.6 Closed seasons

Closed seasons may be useful in preventing damage through shoreline species collection at certain times of the year, whether to target species, non-target species (e.g. wintering birds), or interference with other shoreline uses. Some bait collectors consulted during the review suggested the introduction of temporary closures during the lugworm breeding season. Worms may be of lower quality than usual at this time because of high gamete levels in the body cavity prior to reproduction, and more difficult to obtain immediately after reproduction (they stop casting while larvae are living in the adult burrows). Such closure would be relatively complex to administer because of the difficulty of forecasting and advertising closure times, which would range over a period of some months from beach to beach within any one region. It would be difficult to justify such an approach without evidence that this type of closure did have a beneficial effect on recruitment of young to the bait beds – this research has not been carried out. Closure of depleted white ragworm beds for periods of up to one year has also been suggested as a positive management option. Bait collectors and anglers are, however, reluctant formally to propose these measures to regulating authorities because of concern that this may publicise the location of vulnerable bait stocks and increase exploitation pressure, or because such closures could become permanent.

Closure of bait beds in estuaries during peak seasons of bird activity on the mudflats, or very bad weather, would also reduce disturbance at this most vulnerable period. A temporary ban on shooting during exceptionally bad weather is already possible under existing legislation. A similar tool for bait collection may be a possible solution. Bait collectors may argue that worms are already very difficult to obtain during cold spells, because they burrow more deeply and do not produce fresh casts, and little bait collection activity takes place at these times as a result.

Unfortunately both the main autumn lugworm breeding season and the presence of peak migrating and overwintering shore bird numbers coincide with the period of peak demand for bait, likely making a closed season at this time of year a contentious proposal. However, there may be some benefit in closing recreational bathing beaches to bait collection during the summer when bait stocks are at their peak and alternative sources on less popular holiday beaches more likely to be acceptable. This would reduce conflict between bathers and numerous other summer beach users and bait collectors.

5.7 Zonation

Zonation is an understandably popular means of resolving conflicts between different user groups on the coast by allocating distinct areas for incompatible uses. Alternatives range from the establishment of permanent exclusion zones for certain activities (for example to protect core ‘no-take’ areas of reserves, recreational beach quality, coastal structures, commercial or recreational shipping infrastructure *etc*.) to temporary, rotational zonation operated on a time scale varying from months to years. Enforcement is simplified and partly self-regulating where implemented with the consensus of major bait digging user groups.

In most cases, the effectiveness of zonation for managing bait collection activity will depend on the size of the local sand and mud flats and demand for bait, which is affected by the size of the local or regional angling population and retail demand.

Rotational zonation allows over-exploited stocks and damaged habitats to recover while new stocks are utilised. It is a useful approach for management of bait stocks and more likely to be acceptable to shoreline species collectors than permanent closure because larger quantities of target species may be collected as areas are rotated. Several case studies in literature demonstrate how areas zoned as no-take refuges can act as sources of recruitment to adjacent fisheries. It is logical to expect that unexploited areas adjacent to exploited bait beds will benefit in the same way. The Budle Bay case study (Appendix II) demonstrates that unexploited areas acted not only as sources of juvenile recruitment of lugworm, but also adult migration from densely populated bait beds. This management approach is, however, more confusing and difficult to enforce than permanent exclusion and can not provide permanent protection to vulnerable habitats, coastal structures, or fragile and/or long-lived fauna or habitats of nature conservation importance requiring long-term protection from physical disturbance.

Permanent exclusion from specified areas is effective because it is easily explained and understood and cheaper to administer and manage. For this reason, most examples of species collection zonation in the case studies (Appendix II) were either originally established as or eventually ended up as permanent exclusion areas. The Boulmer Haven case study (Appendix II) may become an example of best practice for the zonation of bait collection activity.

Zonation has been underway for many years at Cleethorpes, where part of the beach is permanently open to bait digging and part reserved for other beach users under local authority byelaw. Bait diggers have complained to the local Council, that the habitat used by bait diggers and its bait stocks are inferior to those in the closed area of the beach. They asked for the zonation to be discontinued so that they have access to the whole beach. The Council, however, was advised that the reason for this difference in beach quality is purely due to the activity of bait collectors, and have maintained the *status quo* (P. Olive pers. comm.).

5.8 Closure of bait beds

If management under voluntary agreement, limited zonation or licensing fails, escalation of control to the complete prohibition of collection at a site has tended to occur. This is easier for managers to administer and enforce than any other management option. Recent case law, however, demonstrates that closure of any one site can only be a regulatory measure and must not completely stop bait collection in an area. Alternative bait sources within a reasonable distance of the closed site must remain accessible to collectors. If this were not the case, case law would support a challenge by anglers to closure of bait beds. Effectively, therefore, closing bait beds completely is a form of zonation (described above) on a larger scale.

Enforcement of legal closures of bait beds by regulatory authorities has sometimes been hampered by the rather cloudy legal position of the public right to collect shoreline species. There is also an overall unwillingness on the part of authorities to resort to the expense of a prosecution (and subsequent appeals) to test the law. Recent judgements in case law have still not fully resolved the legal position.

Closure of a bait collection site has been shown to increase pressure on stocks and may cause unforeseen conflict at other sites up to 100 miles away, as demonstrated by the case of the Budle Bay case study in Northumberland (Appendix II). A similar situation arose in the Helford River, where bait digging pressure increased as a result of restrictions on other estuaries such as the Newlyn, Hayle and Fowey (Minutes of meeting of Helford Voluntary Marine Conservation Area, 6/1/93). There are also reports of bait diggers from the Newcastle area travelling to southwest Scotland in order to collect bait, as a result of bait bed closures on the Northumberland coast (D. Donnan pers. comm.).

Careful assessment of the likely results of a bait collection ban and consultation with other site managers in the region is therefore essential before a closure is implemented. Ultimately, closure of bait beds should only be undertaken as a last resort and as part of an overall regional strategy for bait collection.

5.9 Prohibition of commercial bait collection activities

Commercial bait collection is a potential source of conflict among bait collectors and between collectors and other users. It is not part of the public right to fish, but is widely tolerated by managers and landowners and will continue to provide an important source of bait for many recreational anglers until farmed bait becomes more widely available. Commercial bait collection may be licensed formally by landowners (who may not, however, regulate competing non-commercial collection activities in order to protect commercial resources). A very few collectors have rights to collect bait commercially in specified areas.

Although commercial bait collectors are frequently seen as the major culprits causing unacceptable environmental effects or conflicts with other foreshore users, such a reputation may not be warranted. The important distinction between professional collectors and the unemployed casual collector has already been noted (see section 5.1). Professional commercial collectors provide an important source of bait for a great many sea anglers, including a great many of those who are unable to collect their own for various reasons, and are an important asset to the sport of sea angling. They are also more likely to adhere to good practice than many anglers who do not belong to a representative body. Unregistered, unprofessional commercial collectors are more likely to be responsible for environmental damage.

Banning all commercial collection would result in reduced commercial supplies (until supplies of farmed bait improve) and rising retail bait prices, leading in turn to increased bait collection effort by larger numbers of recreational anglers. This would likely have a greater environmental impact than the small number of commercial diggers previously supplying them. This effect could occur not only in the area of the ban, but also further afield (collectors supply retail outlets over a very large area). A ban might also lead to larger quantities of bait imports for the retail trade, including an increased possibility of the introduction of non-native bait species to UK waters.

If still considered desirable, a ban on all commercial bait collection would be extremely difficult to enforce. The distinction between recreational and commercial bait collection is too difficult to define to make discrimination against commercial collection possible. This is because of the difficulty of proving in court that collection was being undertaken for commercial purposes, and not for personal use over the next few days, or for the personal use of friends or family (for which no charge would be made).

The option favoured by most professional bait collectors is to legalise and control commercial collection through license. This has already been discussed in section 5.5. Doing so on a national basis will likely require new legislation, and introducing such controls locally may be difficult for SAC management groups and less effective.

5.10 Development of regional bait collection management strategies

As noted above, any regulation or restriction of collection activity, whether by commercial or recreational bait diggers, has possible implications for other sources of bait at least 100 miles away. Any regulation of bait collection must therefore be considered not within a single site, but on a regional basis. It is recommended that regional networks of site managers should be established to consult with national and regional angling representative groups and professional collectors on the implications of proposals to regulate this activity.

5.11 Improving retail sources of bait

Many anglers prefer to purchase their own bait, rather than travel long distances or incur the discomfort of collecting their own supplies from the shore (particularly in winter). Rising prices and poor quality retail stocks will, however, still drive many anglers back onto the shore. Increasing quantities of bait derived from farmed stocks of native species are now available through retail suppliers. Up to now king ragworm *Nereis virens* has been the main species available, derived from native stocks in the Netherlands, but lugworm farming is under development and should begin to yield blow lug *Arenicola marina* and/or black lug *A. defodiens* supplies soon. Other species (catworms *Nephtys* spp. and peeler crab *Carcinus maenus*) may soon follow. This trend should lead to a reduction of bait collection effort on the shore. Eco-labelling might help to promote sales of environmentally-friendly farmed stock and should be encouraged.

Imports of native bait species also take place from wild fisheries in Ireland and the Netherlands. Such imports are of great importance for angling, but it cannot be guaranteed that these are from sustainably managed stocks – there is no management yet of bait collection in Ireland. Import of unmanaged, unsustainable commercially dug worm stocks from any area is undesirable. As with the provision of farmed worm stocks, eco-labelling for sustainably managed worm fisheries should be considered.

Small quantities of lugworm taken as a bycatch from bivalve fisheries in south-western England are now also available to the retail trade.

Imports of non-native species (e.g. from Japan or Korea) to other European countries, particularly in the Mediterranean, are becoming widespread. No evidence was obtained of any such imports of live bait to the UK, and the introduction of any non-native species to the sea in the UK would be illegal under the Wildlife and Countryside Act (1981). Steps should be taken to actively discourage retailers or worm farmers considering such imports, and to inform anglers that release to the wild of non-native species is a prosecutable offence under the Wildlife and Countryside Act (1981) and could be environmentally damaging. The potential environmental implications of introducing large predatory Polychaete worms to UK waters are alarming.

5.12 Utilising and improving regulating legislation

Bait digging is completely unregulated by legislation targeted specifically at this activity. It is sometimes argued that the ancient public right to collect bait, as exists in England under the Magna Carta, is an anachronism today, and new legislation should be drafted to extinguish this right, improving potential control under existing byelaws. If such new legislation was to be aimed specifically at the regulation of bait collection activity, it might enable the competent authority to set minimum sizes, prescribe collection techniques, and establish closed seasons or closed areas.

A range of other legislative controls for bait collection are available, as discussed in Chapter 4 and summarised in Tables 9 and 10. These all have limitations, some would benefit from government guidance regarding their application for this purpose, and none can extinguish the public right to collect bait for personal use.

Fisheries legislation and byelaws are a well-established means of controlling fisheries activities, with Fisheries Officers responsible for policing and enforcement on site. The shore or green crab *Carcinus maenus*, which is most commonly collected for bait, and other species of sea fish not regularly taken in commercial fisheries are not named in any present fisheries regulations or byelaws. New byelaws would therefore be required to enable Sea Fisheries Committees in England and Wales to introduce permits for the collection of these species, control methods of capture, or require catches to be reported. Fisheries legislation would have to be amended to allow bait worms and other ‘non sea fish’ to be covered by fisheries byelaws. Given that resources for commercial fisheries management are already severely limited, and the regulation of bait collection is such a difficult area, it is most unlikely that fisheries authorities would be enthusiastic about adding to their existing responsibilities and duties in this way.

Where shoreline species collection activity releases pollutants, or deposits materials on the shore, it may be controlled under the Food and Environment Protection Act 1985 (FEPA). Bait dredgers wishing to work in estuaries in south-east England would have been charged such a high sum for a licence under FEPA to permit them to discharge sediments (including potentially high quantities of contaminants) back into the sea, that the operation would have been uneconomic. Deposition of crab shelters would be covered under FEPA if those responsible were actually caught undertaking this activity – proof of deposition is otherwise very hard to prove.

Several other authorities have the ability to control bait collection to minimise conflicts with the various interests that they are empowered to protect under statute. Examples are described elsewhere in this report. However, there seems to be a degree of inconsistency in determining whether such byelaws may be introduced. Government guidance for the consistent regulation of this activity under Harbours and Transport Acts, Public Health Acts and other local authority Acts, would be very valuable, but recommendations for such guidance are outside the scope of this report.

Sustainable regulation of shoreline species collection would be improved if the legislation allowed managers to discriminate between individuals when regulating fisheries, including by issuing restricted numbers of conditional licences, for example to local communities or recognised user groups only. Imposing charges would enable managing bodies to raise funds for enforcement (and protection of licensee’s rights). Resistance to such innovation would be considerable.

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Appendices

Appendix I. Target species

A.I.1 Introduction

This Appendix briefly introduces, in taxonomic order, those species of marine fauna that may be targeted for collection from the intertidal of rocky and sediment shores in the British Isles. The list includes both species that are taken for human consumption and those used for fishing bait (some are used for both purposes), and for commercial and non-commercial purposes. The list also attempts to draw attention to species and groups of species that are currently under-utilised in the UK, but collected in other areas of Europe, or are very similar to species widely collected in other parts of the world. A few predominantly sublittoral species of high value and commercial importance are also listed, but most of the taxonomic groups that are not collected on the shore do not appear below.

Flowering plants and algae are also gathered from the shore (e.g. *Salicornia* is taken for consumption from mudflats on the upper shore, at the bottom of the saltmarsh zone, and a wide range of seaweeds are used as fertiliser, for food and occasionally bait), but have not been included in this review.

Unless otherwise specified, the main sources used below were Hayward and Ryland 1995, Howson and Picton 1997, and Fowler 1992.

A.I.2 Phylum Annelida : True Worms

Worms are the most important of bait species collected in the UK, by digging on sediment shores. Their exploitation is also completely unregulated, since they are not classified as seafish and do not fall under the scope of fisheries legislation.

A.I.2.1 Class Polychaeta : Bristle worms

This Class is the largest group of worms. All are aquatic and the great majority is marine. A few polychaetes are commensal or parasitic, but most are free-living and include pelagic swimmers, crawling and actively burrowing species, and tube-dwelling species. However, only a very small number of the over 1,000 species which occur in UK waters are sufficiently large, robust, common and easily obtained to be target bait species.

Order Phyllodocida

Superfamily Nereidoidea, Family Nereidae : Ragworms
Ragworms are very common errant (free-living) polychaetes all around the British Isles. Nineteen species have been recorded on British coasts, in nine genera (Knight-Jones *et al*., in Hayward and Ryland 1995).

All Nereidae are semelparous (or monotelic), breeding only once in their lifecycle before dying. When male and female ragworms reach maturity, hormonal changes cause their bodies to alter. Their digestive systems break down, to enable large numbers of eggs and sperm to be produced, and most species develop large eyes and swimming legs in preparation for leaving their burrows to spawn at the water surface. A combination of a temperature cue and lunar cycle stimulates the release of pheromones and gametes from all the mature worms in the population. Spawning during spring tides probably ensures the maximum dispersion of fertilised eggs in the water column. Some cultures collect spawning, protein-rich, reef polychaete worms for food (e.g. *Palolo palolo* worms in Samoa, South Pacific).

Some ragworms are capable of maturing and breeding after just one year’s growth in good conditions, but most important bait species take rather longer. King ragworms *Nereis virens* are two or three years old before hormonal changes trigger breeding in UK populations. Usually, therefore, about one third of the population will breed every year. However a proportion of the large king ragworms in the Menai Strait population exhibit delayed maturity, with only about 20% spawning each year (Coates 1983, Olive 1987).

The omnivorous nature of ragworms, their fast growth and swift maturity, makes them very suitable for large-scale commercial bait worm farming. This has the capacity to alleviate some baitdigging pressure from sensitive intertidal areas. However, farming may also result in the accidental release of non-native species imported for use as bait, or for farming in the UK. Non-native species are increasingly being imported into mainland Europe from Korea, Taiwan and the USA to satisfy demand for bait (Olive pers. comm.). Roch *et al.* (1990) report on their purchase from a retail shop in Italy of a *Nereis* sp. from the Yellow Sea, Japan.

The following species are most commonly collected for bait on UK shores:

<u>*Hediste* (*Nereis) diversicolor* (O F Müller, 1776). Harbour rag</u>. A greenish, yellowish or orange worm with a prominent dorsal blood vessel some 60-120 mm long. Feeds by spinning a mucous net to catch food particles (mainly dead organic material) suspended in the water. Found burrowing in intertidal black (anoxic) muddy sand, often in brackish areas, around most British coasts, and north-west Europe as far as the Mediterranean. Neither sex leaves their burrows when spawning and larval young do not disperse very far. Feeding birds may take up to 90% of the population during the year (Mettam 1981).

<u>*Neanthes* (*Nereis) virens* (M Sars, 1835). King rag</u>. A large dark green worm with large leaf-like dorsal lappets giving a fringed appearance to the body. This commonly grows to 200-300 mm long, and much more in a few areas (notably the Menai Strait, where maturity is delayed in a significant proportion of large worms). The king rag occurs in a mucus-lined burrow in black muddy sand habitat on most British shores. It scavenges and can take small invertebrates with its large jaws (although these may be used mainly for defence). Male king ragworms swim out of the burrows to spawn and fertilisation of eggs takes place inside the females' burrows. There is a brief planktonic larval stage. Large numbers of dead males are sometimes reported washed up after spawning. The king rag is a highly valued bait species, and is particularly common in the south and west and on the Atlantic coast of Europe. It is farmed for commercial bait production, but some commercial bait outlets report that farmed ragworm do not travel well and can be of poor quality.

<u>*Perinereis cultrifera* (Grube, 1840). Ragworm</u>. A bronze-green worm with bright red dorsal vessel and parapods ('legs'), reaching 100-250 mm long. Makes galleries in mud inside rock crevices, under stones and in eel grass. Common bait species, found all around British coasts, in north-west Europe to the Mediterranean (and in the Indian Ocean).

Superfamily Nephtyoidea, Family Nephtyidae : Catworms or silver rag

Medium or large, smooth, silvery worms which actively swim and burrow in clean sand beaches, usually close to the low water mark. The largest specimens are used for bait and are particularly sought-after by some anglers, including match fishermen.

Catworms do not have permanent, visible, burrows but wander through the sand in search of their prey (which may include smaller conspecifics). They are long-lived and can be aged by counting the annual growth rings in their jaws. An average three-inch long worm is usually four or five years old, and the largest worms in a UK population may be up to 12 years of age (Olive 1985b). Caron *et al.* (1995) report on an 'enormous' individual of *Nephtys caeca* from Canada with 15 visible jaw rings.

Like the ragworms, the catworms have separate sexes and all worms in the population breed on the same day. However, catworms are iteroparous, or polytelic, and may breed several times in their lifetime. Breeding does not necessarily take place every year; sometimes the worms reabsorb their gametes before spawning can occur. Olive (1985b) recorded only two successful spawnings in one species during the ten year period from 1975 to 1985. Catworm larvae have a long planktonic phase and may not settle onto the bottom until five weeks after fertilisation. Their slow growth, infrequent spawning and low recruitment rates make *Nephtys* species very vulnerable to bait digging (it is possible for local populations to be dug out), and also unsuitable for bait culture.

There are about ten species in two genera (*Aglaophamus* and *Nephtys*) recorded in Britain (Knight-Jones *et al*., in Hayward and Ryland 1995), although Howson and Picton (1997) record a larger number in the region. The three most common intertidal species are listed below.

Nephtys caeca Fabricus. 150-250 mm long, common and widespread in the intertidal and at low water all around Britain, and in the Arctic and Northeast Atlantic. Caron *et al*. (1995) report on an individual (>23g) of *Nephtys caeca* sampled in Canada that was over 23 g in weight and 15 years old, in a population with a longevity of over 6 years.

Nephtys cirrosa Ehlers. 60-100 mm long, found in the intertidal and at low water mark all around Britain and on the Atlantic coast of Europe.

Nephtys hombergi Savigny. 100-200 mm long, common and widespread in the intertidal and at low water all around Britain, north-west Europe and the Mediterranean.

Order Capitellida

Family Arenicolidae : Lugworms

The lugworms are the most popular bait worm used by anglers in the UK, and are extremely common. They are collected extensively by anglers for their own use, and by commercial diggers for resale. Two species are commonly used for bait (see below), but since one of these was only described relatively recently, differences in their ecology and life cycles are still not fully understood.

Lugworms live in U or J-shaped burrows on sandy and muddy sand shores, and feed on the remains of decaying seaweed, diatoms and bacteria. They are also found in the sublittoral, in muddy sands and mud, and may be particularly common around sources of organic input (e.g. fish farms). The location of lugworm burrows is obvious from the spiralled faecal sand casts left on the surface above one entrance to the burrow.

Lugworms begin to breed at an age of two years, when they also reach a large enough size to be considered suitable as bait. Each animal spawns on a single day, and the entire population of any beach completes spawning within a few days, although populations on different beaches spawn at different times. Most lugworms breed in winter (October to March), with the majority spawning in November and December. Some 20% of lugworms spawn in summer (July to September, Shahid 1982). Some lugworms die after spawning, and the remainder stops feeding and producing sandcasts for the period during which their larvae are living attached to sand grains in the adult burrows. Adult populations are at their lowest density, and individual worms at their smallest size in winter after breeding. Population density and worm size both increase quickly in spring as growth rates rise and maturing worms migrate into the adult lugworm beds.

Soon after fertilisation, the larvae migrate from the adult beds to a zone just below the low water mark, where they occur in dense populations for the next six months until they reach a length of about 10 mm. They then swim in a mucus tube to the upper part of the shore, where plenty of organic material occurs in a zone just below the strand line (in natural conditions; beach cleaning operations will remove much of the organic input usually provided during the holiday season). Very dense beds of juvenile lugworms occur in this area. The maturing worms eventually move down to the less densely populated adult beds at the bottom of the shore and in the sublittoral. Adult worms are capable of living for six years. They reach weights of 25 g in the south and west, or 10 g in the north-east, and may breed several times during their lifetime.

This complex life cycle makes lugworms very resilient to bait collection pressure, provided that bait diggers do not dig in the nursery beds high on the shore. Populations on the lowest part of the shore and in the shallow sublittoral are only rarely or never exploited. Adult worms will migrate into dug areas from these refuge populations, as well as from the nursery beds. However, the same complexity of life cycle and their relatively slow growth makes lugworms difficult candidates for bait farming, although progress is now being made with the culture of UK species (Olive pers. comm.).

Three genera are reported by Howson and Picton (1997) to occur in and around UK waters: *Arenicola* (two species), *Arenicolides* (three species), and *Branchiomaldane* (one species). Bait collectors actively target the two species of *Arenicola*. The two more common *Arenicolides* species (*A. branchialis* and *A. ecaudata*) are found in mixed sediments among rocks and stones, which are less likely to be dug over by most lugworm collectors (although they will be encountered in this habitat by ragworm collectors).

Other species of Arenicolidae are apparently used for human consumption as well as for fishing bait in East Asia. Trade statistics, based on custom clearance statistics released by the Japanese Ministry of Finance, record that 1,119 MT of lugworms and sea lavenders (living), worth 710 million yen, were exported from Japan to Korea in 1997. (Data from March issue of East Asia Economic Information, published by Tokyo-based East Asia Trade Research Board.) Other sources record that some of these lugworms are processed and canned in tomato sauce, presumably for human consumption.

Arenicola marina (Linnaeus). Blow lug (also known as lobworm and yellowtail). This species occupies U-shaped burrows, marked by a faecal cast and a feeding depression, on the lower shore of clean to muddy sand beaches. Its range extends from the Arctic to the Mediterranean in Northwest Europe. At 150-200 mm long, this is one of the most important UK fishing bait species, dug by hand. The blow lug is sold commercially for bait in many regions, but as a relatively small worm, it is less sought-after than black lug.

Arenicola defodiens Cadman and Nelson-Smith, 1993. Black lug (or runnydown). A larger worm than *A. marina*, and therefore particularly sought after by bait collectors (commercially and for personal use). This species occurs in a lower zone of the intertidal, and possibly on more exposed beaches, in J-shaped burrows marked by a faecal cast characterised by a hole in the centre of the cast (Mr Sharp pers. comm.). It is therefore mainly obtainable during low water spring tides, and is usually collected using a bait pump. It has only recently been distinguished from *A. marina*, and full details of its geographic distribution and life cycle are not yet available. Bait diggers report that the species seems to prefer areas that are relatively enriched, either by local sewage outfalls or exposed shores in estuaries (Mr Sharp pers. comm.). Black lug collected for resale are usually gutted and wrapped in newspaper.

Family Eunicidae

Marphysa sanguinea (Montagu). Verm. Broad flattened body of 300 or more segments and 300-600 mm long. Valued as angling bait in the Channel Islands, but can bite painfully when handled. Found in mucus-lined galleries in muddy sand under stones and among old shells on the lower shore on western coasts of Britain.

Other species of *Marphysa* enter the international trade in bait worms (particularly to the Mediterranean) and their introduction to areas where they do not occur naturally could be environmentally damaging (Peter Olive pers. comm.).

Family Glyceridae

Some 16 species in four genera are recorded in the UK, some of which can deliver a painful bite (said to resemble a bee sting). None of these UK species are known to be used for bait, but this family is introduced here because of the extensive international trade in *Glycera dibrachiata*, a species from the Northwest Atlantic which is imported to Europe (Atlantic and

Mediterranean coasts) and elsewhere (see Section 6.7 below). This species has large jaws with a poison gland, and would be an extremely unwelcome addition to the European marine fauna.

A.I.3 Phylum Crustacea : Crustaceans

This Phylum includes crabs, the second most important bait species in the UK, and also used for human consumption. Crustaceans are classified as shellfish, or seafish, under fisheries statute. Collection of any of these species may therefore be governed by statutory fisheries legislation, regardless of intended use.

A.I.3.1 Class Cirripedia : Barnacles and their allies

None of the Cirripedia that occur on UK coasts are large enough to be collected for bait or human consumption. Stalked barnacles (origin unknown) have been observed on sale for human consumption elsewhere in Europe.

A.I.3.2 Class Malacostraca

This is the largest class of Crustacea. Its members occur abundantly in all marine habitats, and include the familiar crabs, lobsters, shrimps and prawns. Six superorders are recognised (Hayward *et al*. in Hayward and Ryland 1995). Not all of these are listed below, because not all include species of commercial importance or collected intertidally.

Superorder Eucarida

Order Decapoda

The decapods are the largest group within the Malacostraca, which are divided into two suborders. Some authorities classify these species within suborder Natantia, the swimming decapods, and suborder Reptantia, the walking decapods. Hayward *et al*. (1995), however divide them on the basis of gill and leg (pereopod) structure, and larval development. Suborders Dendrobranchiata (with no species listed here) and Pleocyemata are recognised under the latter classification. Infraorder Caridea represents the only British Natantia. The reptant decapods comprise the other four infraorders of the Pleocyemata and the Dendrobranchiata.

Suborder Pleocyemata, Infraorder Caridea

Superfamily Palaemonoidea, Family Palaemonidae : Prawns
Eight species recorded from Britain (Hayward *et al*. 1995). The largest, the common prawn *Palaemon serratus*, is valued for human consumption, and may also be used as bait. However, other smaller species will also be taken. They are usually collected by hand net in the intertidal and shallow water.

Palaemon serratus (Pennant). Common prawn. Up to 110 mm in length, and found from the intertidal (in rock pools, under ledges and in weed) to a depth of 40 m, frequent on the south and west coasts, but scarce in the north-east (North of the Thames).

Palaemon elegans Rathke. A smaller (to 63 mm) intertidal species, found under rocks and stones on all coasts (but possibly more scarce in the north).

Superfamily Pandaloidea, Family Pandalidae : Prawns
Mentioned in passing here because these are also commercially important species - however they are predominantly sublittoral (except juvenile *Pandalus montagui*, which may occur on the shore).

Superfamily Crangonoidea, Family Crangonidae : Shrimps
Eleven species recorded in Britain. With the exception of the common shrimp *Crangon crangon*, all are either restricted to the sublittoral, or too small to be targeted for bait or human consumption.

Crangon crangon (Linnaeus). Common shrimp. A mottled grey or brownish shrimp up to 90 mm in length. Common from the mean tide level to about 50m depth on all sandy shores and sandy pools on all coasts. Collected, mainly for human consumption, with shrimping nets, and sometimes used for bait.

Suborder Pleocyemata, Infraorder Astacidea : Lobsters

Superfamily Nephropoidea, Family Nephropidae
Two species are commonly recorded from Britain; the lobster, and the wholly sublittoral *Nephrops norvegicus* (Hayward *et al*. 1995).

Homarus gammarus (Linnaeus). Common Lobster. Occasionally found hiding among rocks on the lower shore – generally found only at the extreme low water mark (at least partly because of human collection pressure). More abundant in the sublittoral, from the Lofoten Isles to the Mediterranean, Black Sea and Morocco, where it is fished with baited pots.

Suborder Pleocyemata, Infraorder Palinura : Crawfish

Superfamily Palinuroidea, Family Palinuridae
Both British species are wholly sublittoral (from >20 m), taken with baited pots or tangle nets.

Suborder Pleocyemata, Infraorder Anomura : Porcelain crabs, squat lobsters and hermit crabs

Superfamily Paguroidea, Family Paguridae : Hermit crabs
Eighteen species in seven genera are recorded from Britain (Hayward *et al*. 1995). All are adapted to living in gastropod shells. The largest (usually *Pagurus bernhardus*) may be collected from the shore, extracted from their protective shells, and used as fishing bait (together with other crabs). Probably used for human consumption elsewhere in Europe.

Pagurus bernhardus (Linnaeus). Common hermit crab. Reaches a carapace length of about 35 mm, when commonly found in large whelk *Buccinum undatum* shells. Present on the shore from mean tide level into the sublittoral, where it occasionally occurs at depths of as much as 500 m. Very wide-spread in rocky and sandy substrata all around Britain, and from Iceland and Norway in the North to Portugal in the south, and on the American Atlantic coast.

Superfamily Galatheoidea, Family Galatheidae : Squat lobsters
Eight species recorded from Britain (Hayward *et al*. 1995), mostly in the sublittoral. They have been fished (using pots) for human consumption in the UK for several years, but exported to the Continent. However, more recently squat lobsters have begun to make an appearance in fishmongers in the UK, and may be taken from the shore for human consumption. They may also be used for fishing bait.

Munida rugosa (Fabricus). Reaches an overall length of 60 mm, and carapace length of 30 mm. Attractive pinkish-red in colour. Fairly common in stony and rocky habitats from the low water mark of spring tides to 150 m on all UK coasts and elsewhere from Norway to the Mediterranean and Madeira.

Galathea squamifera Leach. A dark brownish green squat lobster, reaching an overall length of 65 mm and carapace length of 32 mm. Common on the lower shore (around the low water mark of spring tides) and in the shallow sublittoral around the British Isles and from Norway to the Azores and Mediterranean.

Suborder Pleocyemata, Infraorder Brachura : True crabs

A large group, including several superfamilies, not all of which are listed below (this report only lists the more common intertidal species). This group includes several commercially important species and some which are routinely collected for bait – the ubiquitous shore crab *Carcinus maenus* is the most common of these.

All crustacea have to shed their external carapaces periodically to enable themselves to grow. Expansion of the body takes place after moulting the old carapace and before the new one has hardened. Crabs entering the moult are called peeler crabs (because their old shell is beginning to lift away from the body). After the shell has been shed, they are called soft shell crabs. Because crabs are particularly vulnerable to predators during these stages, they need to hide away under rocks or other shelters. Many anglers maintain that the hormones released by moulting crabs are particularly attractive to fish, thus making peeler crabs very valuable as bait. Many crab bait collectors therefore concentrates on peeler crabs of all species, but particularly the very common shore crab *Carcinus maenus*.

Superfamily Majoidea, Family Majidae : Spider crabs

A large family, with seventeen species recorded from Britain (Hayward *et al*. 1995). The largest of these are commonly collected for human consumption from the shore elsewhere in Europe, but only rarely in the UK (although commercially fished from the sublittoral for export). They may be used for bait along with other crabs. The largest species and those most commonly found in the intertidal are:

Hyas araneus (Linnaeus). Great spider crab. Found in rocky and sandy habitats from the bottom of the shore to depths of 50 m or more all around the UK coasts (where it is common) and elsewhere on the east and west North Atlantic coasts from the English Channel in the south to Spitzbergen, Iceland and Greenland in the North. Reaches a carapace length of 105 mm and width of 83 mm (for large males).

Hyas coarctatus Leach. A slightly smaller species (carapace length 61 mm, width 44 mm) with a similar northern distribution, reaching its southern limits in Brittany. Also common on all rocky and sandy British coasts from the lower shore to 50 m or more.

Maja squinado (Herbst). Common spider crab. Very large crab, often covered with attached algae, reaching a carapace length of 200 mm, width 150 mm. Found on various substrata from the bottom of the shore to about 50 m; abundant in the west and south-west coasts of Britain, but less common in the North Sea. Occurs as far south as Cape Verde and in the Mediterranean.

Superfamily Cancroidea, Family Corystidae : Masked crabs

Corystes cassivelaunus (Pennant). Masked crab. The only species found in British waters, burrowing into sandy soft bottoms from the bottom of the shore to 90 m. Common on all British coasts, and its range extends from Sweden to Portugal and the Mediterranean. May be dug up by bait diggers and used opportunistically for bait.

Superfamily Cancroidea, Family Cancridae

Cancer pagurus Linnaeus. Edible crab. Found on the shore (from the mid tide level) and in shallow water in Britain, and of significant commercial importance in fisheries. Occurs on all coasts in rocky habitats, from North Norway to West Africa and the Mediterranean. Reaches up to 92 mm in length and 150 mm in width. Large specimens are taken for human consumption, and small crabs, particularly peelers (highly valued as a bait for bass), for bait. There is a minimum landing size for this species, which varies in different parts of the country. Crabs collected for fishing bait from the shore will normally be much less than the legal minimum size, and therefore illegal.

Family Portunidae, Subfamily Polybiinae : Swimming crabs
Necora puber (Linnaeus). Velvet fiddler or velvet swimming crab. (Synonyms: *Liocarcinus puber* and *Macropippus puber*.) Carapace length to 65 mm, width 66 mm. Blue carapace covered with brown hairs and distinctive red eyes. Very aggressive. Occurs in stony and rocky habitats in the intertidal and shallow sublittoral. Widespread and very common all around the British Isles and occurs elsewhere from West Norway to West Africa and in the Mediterranean and Black Sea. Important for human consumption in many parts of Europe, and recently fished (with pots) in the UK to supply overseas markets. Now beginning to be used as food in the UK, but more likely to be collected for bait during searches for peeling shore crabs. [*Any minimum landing size anywhere*?]

Liocarcinus depurator (Linnaeus). Harbour crab. Reaches a carapace length of about 40 mm and width of some 51 mm. Very common on soft, sandy and mixed sediments from the lower shore and into deep water all around the British coast. Occurs elsewhere from Norway to West Africa and the Mediterranean. Large enough to be taken opportunistically for bait (or indeed for human consumption) by individuals in search of shore crabs or other bait species. The smaller *L. marmoreus*, marbled crab, occurs in fairly similar sand and gravel habitats and may also be collected.

Family Portunidae, Subfamily Carcininae
Carcinus maenas (Linnaeus). Shore crab, green crab. Attains a carapace length of 60 mm and width of 73 mm. Extremely common and ubiquitous in all intertidal habitats in the British Isles, from splash pools at the top of rocky shores, to saltmarsh ponds, and in estuaries. Also found in the sublittoral. Occurs on most North Atlantic coasts from Iceland to West Africa, and in the north-east Americas, and also in the Indo-Pacific. Widely collected for human consumption in many parts of Europe, and possibly increasingly so in areas of the British Isles. However, mainly used for fishing bait collection (particularly as peeler crabs – see above), and very widely collected, often for re-release, by ‘crabbing’ or ‘rock-pooling’ children. Despite the abundance of this species, particularly intensive gathering for bait can deplete populations locally, and no minimum landing size applies. The main problems associated with intertidal crab collection, however, are habitat damage caused by individuals turning over boulders in search of crabs and not replacing them, and the huge recent increase in the introduction of crab shelters in south-western estuaries. These crabs are a very valuable product, being worth some 40-50p each in summer and 80p to £1 in winter when supplies are very low and demand at its highest.

A.I.4 Phylum Mollusca : Molluscs

One of the largest and most widely distributed groups of marine organisms. Includes some extremely valuable commercial species. Many species are also valued for their shells, and all species may be collected in small numbers anywhere on the coast by amateur and professional conchologists. They are widely taken for human consumption (for personal use and to supply commercial markets) and may also be used for bait. All species of mollusca are classified as shellfish, or seafish, under fisheries statute. Collection of any of these species is therefore governed by statutory fisheries legislation, regardless of intended end use.

Most species of marine mollusca are dioecious (with separate sexes). Primitive species (e.g. archeogastropods and most mesogastropods) exhibit external fertilisation, with planktonic eggs and larvae that may be dispersed widely. Neogastropods produce smaller numbers of eggs that are fixed to the seabed (limiting their dispersal and ability to recover from over-exploitation). Simultaneous or consecutive hermaphroditism occurs within a few marine molluscs, and all Ophisthobranchia are hermaphrodites.

The taxonomy of the Mollusca is in a considerable state of flux. The following classification broadly follows that in Hayward and Ryland (1995); other publications (e.g. Hepple *et al*. in Howson and Picton 1997) vary this.

A.I.4.1 Class Polyplacophora : Chitons

Herbivorous grazing molluscs living on rock surfaces. Characterised by a limpet-like body made up of a shell of eight interlocking plates attached to a tough mantle skirt around the edge of the animal. Larger species are doubtless taken for human consumption in other parts of Europe and elsewhere, but most British species are too small to be valued for this purpose.

A.I.4.2 Class Gastropoda

Subclass Prosobranchia

Prosobranchs are usually characterised by a coiled shell, sealed by a horny operculum attached to the top of the animal's foot. However, others have internal shells, or cone shaped shells (e.g. the limpets).

Order Archaeogastropoda

Family Haliotidacea : Abalone
Haliotis tuberculata Linnaeus. Ormer. Found from the extreme low water mark of rocky shores to the shallow sublittoral, from the Mediterranean north to the Channel Islands. Not present on British and Irish mainland. Commercially important and hand collected. Slow-growing, possibly taking five to eight years to reach market size, and sometimes subject to pronounced fluctuations in recruitment. The ormer is under severe fishing pressure, and often the subject of strict management to prevent population depletion.

Family Patellidae : Limpets
Patella vulgata Linnaeus. Common limpet. Shell up to 60 x 50 x 30 mm in dimension. Found on all suitable rocky shores from the mean high water mark (highest in shaded and wave exposed sites) to the extreme low water mark. Distribution extends from the Lofoten Islands in Norway to the Mediterranean. This limpet has been an important component of human food since prehistoric times, and occurs commonly in shell middens around the coast. This and related species (see below) are, however, no longer widely collected around the British Isles, and elsewhere. Limpets may, however, be taken from the shore for use as bait (e.g. for crabbing), or on heavily used beaches, simply detached for no apparent reason. An educational programme and 'limpet reserve' is being used to discourage removal of limpets in the Kimmeridge Marine Reserve, Dorset.

Patella ulyssiponensis Gmelin, the China limpet. Slightly smaller (50 x 40 x 20 mm), and restricted to the lower shore (mean low water mark of neap tides) and below. Favours wet areas and exposed shores. Distributed from the Mediterranean to the UK, where it reaches its northern limits in the UK, and absent from shores between the Isle of Wight and Humber, or on the Continent east of Barfleur (near Cherbourg).

Patella depressa Pennant, the black-footed limpet. Slightly smaller than the common limpet and a southern species. Prefers vertical surfaces between the mean high water and mean low water marks of neap tides, on exposed rocky shores. Distributed from the Mediterranean to south-west England and Wales.

Family Trochidae : Top shells
Several small topshells occur in the intertidal in the UK. These are not known to be targeted for bait or for human consumption. However, some of the larger species (e.g. *Gibbula umbilicalis* (da Costa), flat top shell, which reaches a size of 20 x 22 mm, and *Monodonta lineata* (da

Costa), thick top shell, maximum 30 x 25 mm) may be collected as ‘winkles’ along with other small gastropod molluscs.

Order Mesogastropoda

Family Littorinidae : Winkles

The taxonomic status of several of the smaller species and some species complexes within this family is still to be resolved. However, the status of the common periwinkle, the largest species (and most important in the context of this report) is undisputed.

Littorina littorea (Linnaeus). Common periwinkle. The largest littorinid, reaching a size of 32 x 25 mm. It is found in the intertidal of almost all rocky shores (except in conditions of extreme wave exposure) and extending into the sublittoral in northern areas. Most abundant on the mid and lower shore. Tolerant of low salinities, and also found in saltmarsh pools. Distributed from northern Spain to the White Sea, but uncommon in some isolated island groups (e.g. the Isles of Scilly and Channel Islands), possibly because its planktonic egg capsules only rarely reach their shores. This species appears in prehistoric shellfish middens throughout Europe, and is therefore known to have been an important source of food since at least 7,500 BC in Scotland (Ashmore, quoted in McKay and Fowler 1997 b). It is still collected in huge quantities in Scotland, mostly for export to the Continent, and also consumed locally. The official landings figures for Scotland indicate that over 2,000 tonnes of winkles are exported annually. This makes winkles the sixth most important shellfish harvested in Scotland in terms of tonnage, and seventh most important in terms of value. However, since actual harvests are probably twice reported levels, the species may actually be the fourth and sixth most important, respectively (McKay and Fowler 1997 b). The extent of collection activity in England, Wales, and Northern Ireland is unknown, but likely similarly under-reported in official figures.

All winkle collection is completely unregulated, but some buyers set a minimum size of 14-15 mm for marketing reasons. This is fortunately adequate to ensure recruitment to the population. Although reproductive capacity in many species of mollusca is proportional to the size of the female, this is, unusually, not the case for *L. littorea*, which is an intermediate host for a number of parasitic trematodes that can reduce egg production. Rate of infection grows exponentially with age, such that in some populations most egg production may come from the smallest, first time spawners which are generally only some 11-12 mm in shell height (Robson and Williams 1971, McKay and Fowler 1997 b).

Quigley and Frid (1998) report that a previously popular shore for winkle collection in Northumberland has apparently been over-harvested in the past and has a low abundance of winkles, presumably the result of over-collection by commercial collectors. Other popular collection sites have a high relative abundance of small individuals.

The South Wales Sea Fisheries Committee has introduced a byelaw prohibiting the collection of winkles using a vacuum pump. This indiscriminate method hoovers up all sizes of winkles and other molluscs and has the potential to seriously damage local stocks.

Order Neogastropoda

Family Muricidae

Nucella lapillus (Linnaeus). Dog whelk. Reaches up to 42 x 22 mm in size. Very common intertidal species, abundant on virtually all rocky shores from the mean high water mark of neap tides to mean low water springs. Also occurs in the sublittoral, but less commonly. Widely distributed from the Straits of Gibraltar to the Arctic. Not a particularly popular species for human consumption, but may still collected as food together with winkles in some areas. (Some populations were seriously depleted as a result of pollution from tri-butyl tin anti-fouling paints in the 1980s and early 1990s, which prevented reproduction in females.)

Family Buccinidae : Whelks
Sixteen species recorded in British waters, but almost all are sublittoral.

Buccinum undatum Linnaeus. Common whelk. Large gastropod, up to 110 x 68 mm. Occasionally found at the low water mark of spring tides, where it might be collected, but usually sublittoral on hard and soft substrata. Fished commercially in some parts of the country using baited pots.

A.I.4.3 Class Bivalvia

Predominantly sedentary animals when adult, living attached to fixed substrata, in crevices, or burrowing in bottom sediments after settlement of the planktonic larvae. Traditionally, only a limited number of species have been collected from British shores. However, over the past two decades markets for a wider range of species have been opening up, mainly for export to the Continent, and to a lesser extent, for consumption in the UK. Many of the smaller edible bivalves, such as the Veneridae and Tellinidae, are very popular on the Continent, but are still neglected target species in the UK. Only a few examples of these families are included below.

Family Mytilidae : Mussels
Thirteen species are found in British waters. Two are commonly collected on the shore (but are not easily distinguishable) and a third important species may occur on the lower shore. The others are small, or restricted to the sublittoral. Intertidal mussels have been an important source of human food for at least 300,000 to 400,000 years in Europe (Siegfried 1994), and are still taken in commercial fisheries and for personal use for food and fishing bait. However, the collection of intertidal mussels for fishing bait is now only at a fraction of the level one hundred years ago (McKay and Fowler 1997 a).

Mytilus edulis Linnaeus. Common mussel. Length usually 50-100 mm but some populations are unlikely to reach more than 30 mm, while others can exceed 150 mm. This species can occur in small groups or as dense beds from the upper shore down into the sublittoral, and is widespread from the Arctic south to the Mediterranean. One hundred years ago, huge quantities were being collected by hand for food and for bait for inshore line fisheries. Today, common mussel harvests are a fraction of these historic levels, even though the species is still the subject of important commercial fisheries (usually operated by dredgers working during high tide), and large quantities are picked by hand from the shore in some areas. Market demand is increasing and there is some farmed mussel production, but most landings are taken from wild stocks, these predominantly in England and Wales. The minimum (non-statutory) required size for sale in the UK is about 55 mm.

Mytilus galloprovincialis (Lamark). Mediterranean mussel. Very similar in appearance to the common mussel, and also collected from the shore and in commercial fisheries. This species reaches the northern limits of its intertidal distribution around south-west England, south Wales, and south and west Ireland.

Modiolus modiolus (Linnaeus). Horse mussel. A large species, reaching lengths of over 100 mm. It sometimes occurs on the lower shore, but is most abundant on coarse sediments in the sublittoral, out to depths of 150 m offshore. Occurs around all British shores and south to the Bay of Biscay. Still sometimes collected for food or fishing bait, particularly in Scotland.

Family Ostreidae : Oysters
Formerly an extremely important source of food for coastal and inland communities, native wild oysters have virtually disappeared from the intertidal and shallow sublittoral in the UK. There is a small amount of natural settlement onto the lower shore of introduced species of oyster in some areas. Where populations are present, these are usually protected from public collection by Several Order.

Ostrea edulis Linnaeus. Flat oyster. The native British oyster, found from the lower shore into water depths of about 80 m. This species occurs naturally from Norway to the Mediterranean. It is now very scarce in the wild, as a result of disease, habitat damage and over-exploitation.

Crassostrea gigas (Thunberg). Pacific oyster. Introduced for cultivation in the south-west and south-east, and breeding and settling sporadically in the wild.

Crassostrea virginica (Gmelin). American oyster. An unsuccessful introduction, virtually absent from the UK.

Family Pectinidae : Scallops

Only rarely encountered on the shore, and therefore not targeted by collectors, although large individuals of *Aequipecten opercularis* (Linnaeus), queen scallop, and *Chlamys varia* (Linnaeus), variegated scallop, are likely collected when encountered in some areas. The largest and most valuable species, *Pecten maximus* (Linnaeus), great scallop, is restricted to the sublittoral.

Family Cardiidae : Cockles

Eleven species are recorded from the British Isles. The common cockle is one of the most important intertidal bivalves taken commercially.

Cerastoderma edule (Linnaeus). Common cockle. Up to 50 mm in length, and found in sandy muds, sands and fine gravels from the mid tide level to just below the extreme low water mark of spring tides, sometimes in extremely dense beds, and often in association with bait worms. Common on all UK coasts (including estuaries), and its range in the Northeast Atlantic extends from north-east Norway to west Africa. Collected by hand and mechanically for the commercial market, and by hand for personal consumption. Conflicts have been reported between cockle gatherers, and bait worm diggers (bait digging can smother cockles and cause serious damage to the cockle bed habitat, Jackson and James 1979, Shackley *et al*. 1995).

Cerastoderma glaucum (Poiret). Lagoon cockle. Broadly similar in appearance and size to the common cockle, and overlapping with part of its range, but restricted in distribution to brackish water habitats. Recorded on the UK coast from East Anglia to South Wales (but likely to occur elsewhere in suitable habitats), and elsewhere in Europe, the Mediterranean and Black Sea. Reported to be less palatable than the common cockle (R. Mitchell pers. comm.).

Family Veneridae : Venus or carpet shells

An important commercial family of bivalves, particularly in Continental Europe, and collected from the wild for sale (often for export) and for personal consumption. Some species are entering cultivation. Genera include *Venus*, *Venerupis*, *Tapes*, *Dosinia* and *Mercenaria*. A few examples of important species are given below.

Mercenaria mercenaria (Linnaeus). Quahog. A large (to 120 mm) and valuable edible bivalve, introduced into the UK from the USA on occasions since the mid 19th Century. Self-sustaining populations still present in Southampton Water and the Solent (where fisheries have conflicted with nature conservation interests) and at Burnham-on-Crouch. Found in lower shore and shallow sublittoral muddy habitats.

Tapes rhomboides (Pennant). Banded carpet shell. Solid shell, up to 60 mm long. Burrows in coarse sands and gravels from the lower shore and into deep water offshore. Found on all British coasts and from Norway to the Mediterranean and north-west Africa.

Tapes decussatus (Linnaeus). Chequered carpet shell. Solid shell, up to 75 mm long. Shallow burrower in sand, muddy gravel and clay on the lower shore and in the shallow sublittoral. A southern species, occurring mainly on southern and western UK coasts and south to the Mediterranean and West Africa.

Family Mactridae
Another potentially important commercial family of bivalves, although under-exploited in the UK compared with Continental Europe and the USA. One fisherman has started a *Spisula* fishery in south-west England, taking surf clams from shallow water using a dredge and air lift. A significant and saleable bycatch of lugworms *Arenicola* sp. is reported (P. Coates pers. comm.). An example is:

Spisula solida (Linnaeus). Thick trough shell. Very solid shell, up to 50 mm long. Burrows in sand on the lower shore and in the sublittoral. Occurs from south Iceland and Norway to Spain and Morocco, and widespread in British waters.

Family Tellinidae
A potentially important commercial family of bivalves. Includes several species commonly eaten on the Continent and present in the intertidal. Genera include *Angulus*, *Fabulina*, and *Macoma*.

Family Scrobiculariidae
Two genera in British waters, *Scrobicularia* and *Abra*.

Scrobicularia plana (da Costa). Peppery furrow shell. Up to 65 mm in length, and restricted to deep burrows in soft estuarine tidal flat and muds. Ranges from Norway to the Mediterranean and West Africa, and is widely distributed (often abundant) around the British Isles. Traditionally collected for food (as indicated by its common name).

Family Solenidae : Razor shells
Large, actively burrowing bivalves with shells which gape at each end and have an external ligament. Most species are restricted to the lower shore and shallow sublittoral, where they burrow in sandy sediments, and all are widely distributed around the UK and from Norway to southern Europe or northern Africa. Razor shells have traditionally been hand collected for food (or possibly bait), both for personal consumption and for resale (usually for export to the Continent). They have recently been the target of mechanical commercial harvesting using sublittoral suction-dredgers. Hand and mechanical collection are both controversial, potentially conflicting with nature conservation interests. An example is:

Ensis ensis (Linnaeus). Common razor shell. Large bivalve, up to 130 mm long (*E. siliqua* and *E. arcuatus* are larger). Found burrowing in fine sand on the lower shore and shallow sublittoral around all British coasts, and distributed from Norway to the Mediterranean and North Africa.

Family Myacidae : Gaper shells
Three species in British waters. Of considerable commercial importance in other parts of the world (these are among the clams used in American clam chowder).

Mya arenaria Linnaeus. Sand gaper, or soft shell clam. Oval shell with pronounced posterior gape, up to 150 mm in length. Found in sand, often mixed with mud or gravel, from the lower shore to a depth of 20 m. May be extremely common in estuaries, where extensive beds are sometimes found. *M. arenaria* is a circumboreal species in the North Atlantic, not reaching the Mediterranean.

Mya truncata Linnaeus. Blunt gaper. Similar to *M. arenaria*, but with abruptly truncated posterior, only reaching 70 mm in length. Found in mixed sandy sediments from the lower shore to a depth of 70 m around all British coasts and circumboreal, extending south to the Bay of Biscay in the NE Atlantic.

A.I.5 Phylum Echinodermata : sea urchins, starfish, brittlestars and sea cucumbers

Sea urchins and sea cucumbers are collected for human consumption in some parts of the world, but not to any significant in UK waters, where there is no recent history of consumption of echinoderms and their collection is not covered by statutory fisheries legislation. The edible purple sea urchin, *Paracentrotus lividus* (Lamark), which occurs in intertidal rock pools and in the shallow sublittoral, reaches its northern limits of distribution in the British Isles and is only extremely rarely recorded in Devon and Cornwall. The common or edible sea urchin, *Echinus esculentus* Linnaeus, is very abundant in the shallow sublittoral on most rocky coasts, but hardly ever occurs in the intertidal. The gonads of both these species are a delicacy in many southern European countries, where there is a market for the species. The green urchin *Psammechinus lividus* is common in some intertidal areas, but is much smaller and not known to be widely collected for food in the UK. Trials are underway in Scotland to develop this species in cultivation for markets in the Far East, but collection from the wild is unlikely as supplementary feeding in artificial conditions is necessary to produce a marketable roe (D. Donnan, pers. comm.). Burrowing sea urchins (e.g. *Echinocardium* spp.) are locally common on many British coasts, extending from the lower shore to deep water. These fragile organisms are not used for bait or taken as food, but intertidal individuals may easily be damaged during bait digging activity.

A.I.6 Phylum Chordata

A.I.6.1 Subphylum Urochordata : Tunicates

Sea squirts are collected from the intertidal and sublittoral for human consumption and for bait in some parts of the world, including the Mediterranean and east Asia, but not in the UK. The introduced ascidian *Styela clava*, common in the sublittoral of some south coast harbours, is an important edible species in Korea and other parts of its natural range.

A.I.6.2 Subphylum Euchordata (vertebrata) : Pisces

Class Osteichthyes : Bony or teleost fishes

Only a small number of fishes occur in the intertidal, and very few of these are collected to any extent. The exceptions include some small fishes regularly found hiding under rocks or in rock pools, which may be taken for aquaria or possibly for bait. Examples of these are the rocklings, blennies, butterfish, and cling fish. Such collection may have significant nature conservation implications in the case of rarities, e.g. the giant goby, *Gobius cobitis* Palas, which occurs in high level tide pools in Cornwall. Additionally, sand eels (lesser sand eel *Ammodytes tobianus* Linnaeus, and greater sand eel *Hyperoplus lanceolatus* (Lesauvage)) occur buried in sandy beaches below the mid tide level and are common on all UK coasts. These important bait species are more likely to be taken with seine nets in shallow water than dug on the shore.

Appendix II. Case studies of shoreline species collection and management

A.II.1 Strangford Lough candidate SAC, Northern Ireland

The hand collection of intertidal animals from the shores of Strangford Lough is a traditional activity in the area. Bait digging for lugworms and ragworms takes place on sediment shores, where cockles are also collected. Winkles and peeler crabs are collected for personal consumption and for fishing bait, respectively.

Extensive intertidal areas of the Lough are in private ownership, and private ownership of subtidal areas is also claimed (but disputed by the Crown Estate Commissioners). The National Trust is one of the major land-owners in the area (following transfer of land formerly part of the Londonderry Estate). The National Trust has made byelaws to protect the areas of land and the habitats and species it supports which prohibit the disturbance, injury or destruction of any living creature (so far as this does not affect the rights of any person).

The judgement of Mr Justice Girvan in the case of Adair v The National Trust upheld the common law right of a member of the public to gather shellfish (winkles and/or whelks) from the waters, bed, and the foreshore of the Lough owned by the National Trust. There can be no discrimination between individuals who fish – whether commercially or as a recreation. The judgement considered that the public right to fish in tidal waters is usually extended to include the collection of fish, including shellfish, on the exposed foreshore when the tide is out. This conclusion was partly based on the consideration that the common law right to collect shellfish from tidal waters permitted the removal of shellfish during periods of high water from areas that would become foreshore later in the tidal cycle, and that it was not logical to exclude collection from the same areas when the tide went out.

The court also decided that members of the public could take worms from the foreshore as an ancillary to the public right to fish, but not otherwise (e.g. not commercially).

A.II.2 Berwickshire and North Northumberland Coast candidate SAC, England

Collection of intertidal animals takes place from both sediment and rocky shores on the Berwickshire and North Northumberland Coast. Bait digging in the area, mainly for lugworms, has been the subject of extensive study and legal regulation in the Lindisfarne National Nature Reserve and Boulmer Haven. Additionally, virtually every accessible intertidal reef is exploited by commercial and recreational users who collect winkles, mussels and crabs by hand.

There are some important case studies on bait digging within this cSAC.

A.II.2.1 Budle Bay, Lindisfarne National Nature Reserve, Northumberland.

Bait digging has been carried out in the Lindisfarne National Nature Reserve (NNR) since at least the 1960s, and probably much earlier. This activity is concentrated in the winter months which is the period of greatest demand for lugworm as angling bait. In the late 1970s, concern was voiced over the impact on bird populations of the rising numbers of bait diggers operating both by day and by night in Budle Bay, the sanctuary area of the NNR. The Nature Conservancy Council proposed banning bait digging in the area except by permit for local fishermen with effect from October 1978. The ban was deferred pending discussions with the National Anglers Council and Northern Federation of Sea Anglers Society (NFSAS), but it became apparent that action was needed when local landowners complained of crop damage by geese displaced from the Bay and a lessor of part of the NNR threatened not to renew his lease.

A compromise agreement was reached with angling groups in the region to close Budle Bay to bait digging for two years, from September 1982 to September 1984. Meanwhile, bait digging would be permitted on Fenham Flats, on either side of the main Lindisfarne Causeway. The effect of the agreement on lugworm stocks and bird numbers would be monitored throughout this period, and if bait stocks on Fenham Flats were found to be inferior, part of the Bay would be reopened for a two year trial period. During the initial period of closure, bird numbers increased in the Bay.

Because lugworm densities and worm sizes were significantly lower on the Flats, and this area also a longer journey for most anglers, an experimental bait digging zone in Budle Bay was reopened to bait digging in September 1984, with support from the NFSAS. The initiation of the experiment not only coincided with the autumn/winter season of peak demand for bait and lowest natural population density of lugworm, but also with a coal miners' strike during the first 6 months of the trial. The result was high levels of commercial bait digging, as well as collection by anglers visiting the area from as far as 30-100 miles away. Intensive bait digging (by up to 120 persons at one time) took place, removing virtually all lugworm from the experimental area within about eight weeks from reintroduction of bait digging. Some 25% of bait diggers present in January 1985 (and 50% of those in January 1987, well after the miners' strike) were observed digging outside the agreed zone. Other infringements of the agreement included a lack of backfilling and use of artificial lights. Bird numbers using the Bay also fell significantly, mainly because of disturbance caused by the presence of bait diggers, excluding the birds from feeding grounds, rather than because of the effects of digging on their infaunal prey items (the areas of mudflat favoured by feeding birds coincide with those favoured by bait diggers). Unanticipated impacts of bait digging at this site included damage to commercial mussel beds operated under licence in the Bay and the mobilisation of heavy metals (lead and cadmium) in the deep sediment, which were then taken up by burrowing invertebrates.

The experiment clearly demonstrated that bait digging activity was incompatible with the aims of the sanctuary area and Budle Bay was closed again to bait digging from September 1987. This was effected under the NNR byelaws, made in 1968, which prohibit various acts except as authorised by permit, including 'molesting or wilfully disturbing, injuring or killing any living creature', and was largely effective. Despite the virtual depletion of dug areas, lugworm numbers recovered very rapidly after bait digging ceased at the site, as a result of immigration of adults from adjacent unexploited sites. Bird numbers using the area after the second closure also rose considerably.

The 1992 judgement in Anderson v. Alnwick District Council, that bait digging for personal use was ancillary to the right to fish (see below), nullified the NNR byelaw 2(1)(a) as regards bait digging for personal use, and identified problems with the seaward extent of the NNR byelaws. It resulted in an upsurge of digging during the late summer and autumn of 1993. English Nature initially considered simply amending the byelaws to take account of this judgement, but because this would take some time, issued a Nature Conservation Order (NCO) in October 1993 to restore control over baitdigging in Budle Bay immediately. The NCO was seen to be largely effective after a few weeks. The NCO and the proposed amendment to the Lindisfarne NNR byelaws were opposed by representatives of four sea angling federations, and a Public Inquiry held in March 1994. The Inspector, however, upheld the Nature Conservation Order and modifications suggested by English Nature, which included defining the Order's seaward extent to a vertical depth of 6 m below the low water mark, and broadening the restriction to include "removal of fauna for use of bait whether by digging or by any means" (thus covering the use of, e.g. bait pumps - and incidentally peeler crabs) (Langton 1994).

Because the worm stocks at Fenham Flats, to which baitdiggers were provided open access, are not as good a source of bait as Budle Bay (although possibly adequate for personal bait, if not for commercial collection), and were further to the north, on occasions that Budle Bay has been closed to bait digging (particularly in 1982 and 1985), some bait digging activity has been redirected to other southern locations. Notable among these were Boulmer Haven and Newton Haven (see below), where bait digging had not previously been such a problem. This redirection of bait collection activity to other sites in the area (up to or exceeding a distance of 100 miles away) is likely to take place whenever restrictions are imposed at a favoured site. This case study also demonstrates the major limitation of voluntary agreements with user groups - not all individuals undertaking bait collection activity are members of these groups and/or willing to for their activities to be restricted in this way.

A.II.2.2 Boulmer Haven, Northumberland

Bait digging in Boulmer Haven has been a source of concern to local fishermen launching their cobles across the beach for many years. The holes and rocks left on the shore by bait diggers make launching difficult, and are potentially damaging to boats and tractors. For this reason, the Northumberland Estates (owners of the foreshore) placed notices prohibiting bait digging in the launching area, but permitted bait digging anywhere else on foreshore owned by the Duke of Northumberland. An upsurge in digging activity occurred when the Budle Bay bird sanctuary area was closed to bait diggers in 1982 and again in the winter of 1984/85. During the latter period, up to 100-200 people a day were reported collecting lugworm in the Haven.

As a result of the increased problems being caused to local fishermen, in 1985 the Alnwick District Council adopted Section 82 of the Public Health Acts Amendment Act (1907) to enable the enactment of a byelaw stating that ‘without lawful right or authority no person shall in any part of the restricted area dig for ragworms or for any form of fishing bait’. The restricted area was defined in the text as ‘such parts of the Boulmer Haven as lie above the low-water line’. Before approving these byelaws the Secretary of State asked for a map of the prohibited area. The District Council provided a copy of the Ordnance Survey map of the area, with the area of restriction hatched. This area extended down to the line printed on the map as the ‘low water mean meridian tide line’. The approved byelaws were returned in March 1996 with the map attached, and published with a reproduction of it.

During a period of extreme low water spring tide in February 1990, bait digging took place in an area of exposed beach lying just below the mean low water mark as defined on the Ordnance Survey map. A bait digger was charged with fishing ‘within the restricted area identified in the byelaws’ and convicted by the Alnwick Justices in November 1990. The bait digger appealed to the Newcastle Crown Court against this judgement. His appeal included the following submissions: that the geographical scope of the byelaws should be interpreted by reference to the map, and that he was not digging within the area hatched on the map; that the byelaws were prohibitory, not regulatory, because they banned baitdigging throughout the Haven and not just in the launching area; and that baitdigging for personal use was a common law right, making the byelaws repugnant to the laws of the land.

This appeal was heard by the Crown Court in May 1991, and dismissed, upholding the conviction. The Court decided, *inter alia*, that: the foreshore or seashore lies between the high water mark and the low water mark, wherever that may be, and the map did not form part of the byelaws; the byelaws were not prohibitory, merely regulatory of the beaches within the local authority area; if there is a public right to fish in the sea, the right to dig bait on the foreshore is not ancillary thereto; and the byelaws were not repugnant to the common law.

A second appeal was heard in December 1992 (Anderson v. Alnwick D.C., 1992 - 1 WLR 1156). The judges concluded that the map did form part of the byelaws, and allowed the appeal on this basis. However, they also agreed that, in the absence of such a map, the restricted area defined by the text of the byelaws would extend to the fluctuating low water line as it is at any time, not just at mean low water.

The judges also held “that a public right to take worms from the foreshore is recognised by the common law and may be properly be described as ancillary to the public right to fish. ... But it does not follow that the right is unrestricted or that it may be exercised by any member of the public at any time or place ... This means that in our judgement, that the taking of worms must be directly related to an actual or intended exercise of the public right to fish. Taking for commercial purposes such as sale clearly is not justified in this way. ...The rule, as we would state it, is that bait-digging on the foreshore is justified by the public right to take fish, when the bait is taken on or on behalf of persons who require it for use in the exercise of that right." This judgement caused a temporary increase in bait digging activity at Budle Bay, Lindisfarne NNR, where one of the original NNR byelaws was nullified by the judgement (see above).

Finally, the court concluded that the Alnwick byelaws were regulatory, not prohibitive, because Boulmer Haven was only a limited area, a small part of the foreshore within the local authority area, and an even smaller part of the Northumbrian foreshore. Although the area affected was larger than fishermen would like, it did not "prohibit them obtaining worms reasonably close by". These judgements are summarised in Evans, L.J. and Macpherson of Cluny J. (1993).

Following this judgement, the District Council has not been attempting to enforce the existing byelaw, which has not yet been repealed. Instead, a number of meetings have been organised between the District Council, the Duke of Northumberland Estate, local police, national and regional sea angling organisations, the Environment Agency and local fishermen from Boulmer in an attempt to resolve the situation. The local fishermen who launch from the Haven had been most severely inconvenienced by bait digging activity and were strongly in favour of a complete ban on the activity over the whole beach. Angling representatives, however, stated that they would litigate against such a ban. A satisfactory solution for all parties now appears to have been reached, with good publicity having been obtained in the specialist angling and national press. The District Council has drawn up a new byelaw dividing the beach into two parts. The demarcation line to be established across the beach will be marked not only on a map, but also by a line of painted boulders on the shore (these are necessary for enforcement because so much digging is carried out at night). Bait digging for personal use by anglers will be permitted to the south of this line, but prohibited to the north where launching of fishing vessels and the lifeboat takes place and moorings are located. No commercial bait digging will be tolerated anywhere on the shore.

The new draft byelaw has been approved by the Home Office and forwarded by the local police to the Crown Prosecution Service (CPS), with a request that the CPS (rather than the District Council) undertake any necessary prosecution of offenders once the byelaw is made. If the CPS also approve the draft, it will be made by the District Council and advertised for comment. Following the previous detailed consultation with fishermen and anglers, the District Council does not anticipate any serious objections. Once any objections have been considered, and resolved as necessary, the byelaw will be sent to the Home Office for approval by the Secretary of State. Signs will be erected in the village and the markers established on the shore.

This case study is a very good example of a compromise solution that appears to fulfil the needs of all parties. It is therefore a useful model for resolving the needs of bait collectors and other users within a single site through zonation, with the backing of legislation enabling the agreement to be enforced. In the latter respect, it differs from the case study at Budle Bay where the zonation agreement was entirely voluntary and could not be enforced, resulting in complete closure of this area of shore to bait collectors. However, the case study also highlights one of the drawbacks of resorting to legal means to enforce zonation: it takes many years of consulation before such byelaws can be made.

Acknowledgements: Tony Farrell, Legal Department, Alnwick District Council.

A.II.2.3 Newton Haven, Northumberland

The National Trust leases land and foreshore at Newton Haven, where a small beach has attracted bait diggers in the past. Numbers increased following the introduction of controls at

Budle Bay in 1982, to up to 15 diggers at a time (a significant number in such a small area) travelling 20 to 50 miles to the site. A ban using standard National Trust byelaws in 1983 and an attempted prosecution reduced the number of diggers to an average of about four. These bait diggers worked below the level of low water of spring tides (outside the original limits of the leased area) where damage was caused to populations of burrowing sea urchins, razor shells and associated fauna that were of scientific interest. The National Trust subsequently applied successfully to the Crown Estates Commissioners for a lease of the seabed in order to control yacht moorings in the Haven and bait digging carried out at the bottom of the shore.

A small amount of bait digging still occurs in the Haven, where policy is now for National Trust wardens to approach baitdiggers, explain that the byelaws exist, that the low shore areas are of scientific interest, and ask them to dig elsewhere. No recent attempts have been made to prosecute bait diggers because of the expense of prosecutions and potential difficulty of success. Recently, a meeting has been held with a number of anglers' representatives, and a proposal for management has been received. The National Trust will consider this in consultation with anglers and with other recreational, nature conservation and local authority representatives.

A.II.3 Cleethorpes Beach, Grimsby

Part of the Cleethorpes beach is permanently open to bait digging and part reserved under local authority byelaw for other beach users. Bait diggers have complained to the local Council that the habitat in the area used by bait diggers and bait stocks there are inferior to those in the closed area of the beach. They asked for the zonation to be discontinued so that they have access to the whole beach. The Council, however, was advised that the reason for this difference in beach quality is purely due to the activity of bait collectors, and that opening the whole beach to baitdigging would simply cause the problem of habitat damage to be extended to the whole of the recreational area.

A.II.4 Crab sheltering devices in south-western England

Collection of peeler and soft shell crabs has been undertaken for many years by recreational anglers and collectors supplying the retail bait trade. Crabs undergoing these vulnerable moulting stages are thought to release pheromones making them particularly highly valued as bait for certain fish species, including bass. Collection has traditionally been undertaken by searching underneath boulders on rocky shores, where moulting crabs usually hide from predators. The damaging effects of boulder turning on rocky shore communities has been described by Bell *et al*. 1984, Cryer *et al*. 1987, Liddiard *et al*. 1989, and others.

A relatively recent development has been the extension of crab collection to sediment shores, particularly in sheltered inlets where tiles, pipes and guttering may be laid on the shore to act as crab shelters. This activity started in the south-west of England, where the warm climate results in a long moulting and harvesting season, and has recently expanded greatly, causing management problems in several estuaries. These crabs are a very valuable product, being worth some 40-50p each in summer and 80p to £1 in winter when supplies are very low and demand at its highest. Because the activity has only intensified within the last few years, there are very few studies available on its extent and impact. There does not yet appear to be any overall pattern to the management of the activity, because patterns of land ownership and management vary considerably from site to site.

An undergraduate project (Godden 1995) investigated the trapping of shore crabs *Carcinus maenus* using guttering and tiles in the south Devon estuaries, primarily around Plymouth. He found that numbers had grown in recent years from none to 8,750 traps at Plymouth, and had increased 10-fold in the Exe and Teign estuaries. It was hard to identify any depletion in crab numbers, due to recolonisation by larval stages of crab. Shellfish farmers have not reportedly noticed any reduction in crab numbers on their oyster and mussel beds in estuaries where crab collection is taking place on a large scale (P. Gibbon pers. comm.). Godden also noted that the shelters also provided habitat for other marine plants and algae, and sources of food for fish and birds.

The Tamar Estuaries Bait Collection Working Group was set up when bait collection (particularly the level and impact of crab trapping and worm digging and the abuse of access and property rights) was identified as an issue of concern by the Tamar Estuaries Management Plan Consultative Document. The Group is comprised of recreational and commercial collectors and recreational marine fishery bodies. Only a few years after Godden's report, the Tamar Estuaries Bait Collection Working Group (1998) reported that there were some 20,000 crab traps in the Tamar Estuaries, of which some 8,000 are commercially used. Commercial traps yield some 90,000 crabs, some 30% of which supply local angling shops and 70% is sold to other parts of the UK. Recreational anglers (who are less active and effective collectors) take some 20,000 annually. The result has been widespread concern over the visual impacts of these tiles, their potential impact on wildlife (crab populations, sediment communities and birds), navigation and moorings, and beach recreation, and future pollution caused by the breakdown of car tyres, where used. Finally, issues of trespass and installation of shelters on private land have caused problems, with landowners removing large numbers of shelters from private foreshore and nature reserves and having to dispose of these.

The Group recommends a voluntary management approach involving all key players, in harmony with the Tamar Estuaries Management Plan. Specifically, the development and implementation of a Bait Collectors' Code specifically for the estuary and an angler/bait collector education programme was proposed. Additionally, the Group suggests that an up to date survey of crab tile numbers and locations and worm digging locations alongside an impact study would allow rational decisions to be made on the need for zoning, controls or permitted growth areas. It recommends using horizontal tiles, rather than shelters embedded at an angle in the shore, and appropriate materials and colours to minimise their visual impacts. Finally, collectors are reminded to use public rights of way to access the foreshore, seek landowners' permission elsewhere, and to consult landowners for permission to place shelters on the shore. Dialogue between collectors and property owners should be encouraged to minimise conflict.

In the Fowey estuary, the Harbour Commissioners discovered that about 300 car tyres had been placed illegally in one area, and 900 plastic drains in another. These were a potential danger in navigational areas and anchorages, and had to be removed. The code of conduct produced by the National and Cornish Federations of Sea Anglers was circulated widely, and articles run in local newspapers. In November 1998 the Fowey Harbour Commissioners put out a public notice concerning the 'LAYING OF OR PLACING HAZARDS TO NAVIGATION TRAPS AND OTHER OBSTRUCTIONS FORESHORE AND FUNDUS'. This stated that any objects laid on the foreshore or fundus will be removed forthwith. As owners of the foreshore and fundus in the estuary, the Harbour Commissioners 'advise persons wishing to establish fishing traps and other fish farming methods that a license needs to be obtained to carry out such operations. Such licences will only be issued having due regard to the environment of the estuary and after consultation with other users and statutory authorities. The licenses to be issued by the Harbour Commissioners will be able to take account of physical carrying capacity, specify the type of structure, and require details of catches to be returned' (M.J. Sutherland pers. comm.). Areas licensed for crab shelters may be marked on charts, and on the ground with beacons, if necessary (this has been undertaken for shellfish farms). The Fowey Estuary Management Plan (progress report November 1998) noted that communication would be sought between the fishermen and the Harbour Office and other interested parties to establish a Voluntary Code of Practice for the Estuary, as achieved on the Tamar.

Crab shelters have recently been installed in large numbers (about 12,500 tiles were counted in March 1999, Russell 1999) in the Teign Estuary, where they are installed at an angle in very soft mud and are highly visible from vantage points. In addition to the aesthetic effect, this activity also caused conflicts with individuals wishing to access their moorings or launch craft, and shellfish farmers visiting their farm sites. Teignbridge District Council has led a voluntary approach to regulation in this estuary. A User Group (River Teign Bait Collectors Association, predominantly of commercial and hobby collectors) has been set up with an agreement to adhere to the Draft Code of Conduct (below), including a moratorium on the introduction of new tiles. The great majority of crab collectors are members of this group,though reportedly a few are not. Overall, the estuary management plan is seen as having been extremely effective at addressing this issue. However, agreement may have been aided by the existence of legal powers of landowners to remove shelters (The Crown Estate own the whole foreshore, but lease areas to TDC, the Harbour Commission and Devon Wildfowlers Association), and fisheries legislation that is potentially able to regulate the fishery if required.

Draft code of conduct

Crab pots, River Teign

This is a voluntary code of conduct agreed between Teignbridge District Council and the River Teign Bait Collectors Association who regulate the use of crab pots on the River Teign.

1. No further crab pots shall be placed on the bed of the River Teign other than in the same location, and as replacements for, those in position on the 1st April 1998.
2. All those crab pots sited in the vicinity of public slipways which are in such a position as to cause difficulties to those landing and retrieving boats from those slipways shall be removed.
3. All those crab pots sited within the swinging arc of existing licensed moorings shall be removed. Provided that if the swinging arc is increased either by the use of a longer mooring or as a result of placing a larger boat on the mooring, then there shall be no obligation to remove the crab pots placed within this increased arc.
4. In the even that mooring positions are reorganised so that a number of boats are moved to a single trot, the provisions in 3 above shall apply to the siting and removal of crab pots in the vicinity of the new mooring positions. Before any such reorganisation of moorings which would require the removal of crab tiles the Council will consult the River Teign Bait Collectors Association.
5. No crab pots shall be placed within X metres of oyster beds or mussel beds and there shall be left a means of access on foot from each oyster bed and mussel bed within a width of at least Y metres to the shore.
6. All crab pots must be correctly positioned, that is to say that they must be placed at such a low angle so as to ensure that they do not cause difficulties for other river users and in any event no crab pots shall be more than 20 cm in height.
7. No crab pots shall be of a material which could affect the quality of the water to the detriment of fish in the river.

As crab shelters have been removed and numbers reduced in each estuary where controls have been implemented, there has been a tendency for the collectors to move further east along the coasts of Cornwall and Devon. Additionally, anglers and commercial collectors are beginning to express an interest in commencing this activity further afield (for example in Milford Haven and on the Lancashire coast). The success of future voluntary controls will very much depend on the ability of regulators to identify a local group of collectors, and this group being strong enough to deal with activities by ‘outsiders’, particularly those individuals viewed as a ‘rogue element’ moving along the coast from estuary to estuary.

Acknowledgements: David Rowe, National Federation of Sea Anglers; Colin Davies, South West Federation of Sea Anglers; Tim Robbins, Devon Sea Fisheries Committee; Natasha Barker, Teignbridge District Council; Mike Sutherland, Chief Executive and Harbour Master, Fowey Harbour Commissioners; Jo Crix, English Nature; and Philip Gibbon.

A.II.5 Burry Inlet, South Wales

The South Wales Sea Fisheries Committee (SWSFC) regulates fishing activities within the Burry Inlet, under the Burry Inlet Cockle Fishery Order 1965. The regulations licence commercial cockle fishers (limiting their numbers) and impose a daily quota. Present byelaws also protect the shellfish beds from “any activity which disturbs or damages the surface of the sea bed within the areas specified... Provided that nothing in this byelaw shall prevent any person from lawfully gathering cockles” (Byelaw 20).

Increasing levels of bait digging activity in the cockle beds during the peak autumn/winter demand for bait and shellfish began to cause a conflict of interest between bait diggers and cockle fishermen in the traditional cockling area (Penclawdd and Llanelli Sands) in the late 1980s. The problem was partly one of difficult access by cockle fishermen over areas dug for bait, and partly direct damage to cockle stocks by digging and smothering under spoil heaps. The SFC therefore sought to introduce a byelaw to limit the areas open to bait digging in order to protect the fishery. The Welsh Office initially suggested that bait digging activity throughout the Burry Inlet should be limited by quota and by permit, with a bag limit of 100 lugworms per bait digger imposed. This would restrict bait digging activity to collection for personal use only and exclude commercial collectors. Bag limits, however, proved to be impossible to enforce, because excess worms could so very easily be concealed while a Fisheries Officer was approaching. It was concluded that a quota system did not work, even on the Burry Inlet that benefited from the presence of a part time Fisheries Officer and the virtually continual presence of licensed cockle collectors during low tides.

In order to obtain Welsh Office approval for excluding bait digging completely from the greater part of the cockle fishery, the SWSFC had to carry out an experiment into the effect of bait digging on cockle stocks (Shackley *et al.* 1995). This demonstrated that bait digging did cause mortality of cockles, as described by James and James (1979) in North Norfolk, and permission to pass Byelaw 20 (see above) was granted by the Welsh Office. This establishes an open area and a closed area for bait digging, and makes enforcement very much easier. The question of whether bait collection within the permitted area is for commercial or for personal use (which would effectively be impossible to prove conclusively) does not have to be addressed, because there is no longer a bag limit for lugworm. The improvement in enforcement of this byelaw may also, in part, be due to reduced demand for bait worms in recent years.

Several prosecutions were taken against infringement of Byelaw 20 when it was first introduced. One persistent offender was prosecuted at Magistrates Court for persistent infringement of the byelaw by digging for lugworm and for a number of obstruction charges. An appeal was lodged to Crown Court, but dropped after the obstruction charges were removed from the conviction. The fines for six charges of baitdigging were reduced upon appeal and paid by the defendant.

A.II.6 New South Wales, Australia

New South Wales Fisheries’ responsibilities under the Fisheries Management Act 1994 cover not only fisheries management, including the establishment of bag and size limits for certain marine species, but also establishing and managing two types of marine protected areas. Aquatic Reserves are permanently designated areas where varying levels of fishing are permitted. Intertidal Protected Areas are areas of temporary fishing closure. Fisheries Officers from NSW Fisheries police and enforce all fisheries regulations (bag and size limits, illegal fishing gear *etc.*) and reserves. The degree of compliance is related to the Department’s enforcement and education efforts.

A.II.6.1 Bag and size limits

Bag limits were first introduced in 1988, defining the volumes of intertidal invertebrates that could be taken in NSW, a four page NSW Fisheries document (Lynch and Prokop 1993) outlines current bag and size limits for intertidal invertebrates. The limits set in 1988, although generally obeyed, were found to be ineffective in controlling harvesting activities and have since been reduced. Some observers consider that the limits are still too high to maintain stocks of intertidal species. The main problem with the regulations are that large groups of people all collect from the same site on the same low tide. Even if all of them collect within their legal limit (which is not always the case), the cumulative impact can be significant. Additionally, since many of these groups are from non-English speaking backgrounds, providing the necessary interpretation and education material is difficult. Fisheries Officers experience considerable difficulties with determining whether these members of the public are aware of the regulations, and with enforcing them. There have also been conflicts between local residents concerned with the conservation of intertidal flora and fauna and collectors, occasionally leading to violence.

A.II.6.2 Aquatic Reserves

NSW Fisheries manages eight aquatic reserves established under sections 194-197 of the Fisheries Management Act 1994. They are permanently designated sites, and cannot be revoked without the approval of both houses of State parliament. The majority was established in the early 1980’s following pressure from various local lobby groups. Their size varies, but all but three reserves are less than 80 hectares. One (Towra Point Aquatic Reserve) has multiple zones, all the others are generally ‘no-take’ areas, but commercial fishing is permitted in some reserves and not others. There is potential for confusion among members of the public over the scope of the regulations for each reserve. NSW Fisheries is currently reviewing each of the reserves to determine whether it is possible to simplify the regulations and make each reserve fully ‘no-take’ (including no fishing).

A.II.6.3 Intertidal protected areas

Concern grew in the late 1980’s over the extent of harvesting intertidal invertebrates on the majority of rock platforms in the Sydney Metropolitan Region. This concern was community driven, with supporting evidence from local Fisheries Officers and researchers from local Universities. NSW Fisheries released a discussion paper outlining the problem and possible solutions for public comment in 1991, and 107 submissions were received. One option was the creation of ‘protected areas’ within which the collection of all intertidal invertebrates was to be prohibited. This was the origin of Intertidal Protected Areas (IPAs).

IPAs are a temporary fishing closure under section 8 of the Fisheries Management Act 1994 and can be revoked at any time by the Minister for Fisheries by written consent. They have a maximum life of five years, after which time they are reviewed and may be renewed for a further five years. Fourteen IPAs within the Sydney Metropolitan region were gazetted in July 1993, and have been renewed by NSW Fisheries until 31 December 1999 to provide time to review their location, enforcement, education, effectiveness *etc*. The review should commence at the end of 1998.

IPAs protect all rocky intertidal habitats, from the mean high water mark to 10 metres horizontally seaward of the mean low water mark. The collection of all intertidal invertebrates (whether for food or bait) is strictly prohibited within IPAs. An exception is made for the collection of abalone and rock lobsters, valuable commercial fishery species that already have strict quotas and management regimes in place. Fishing is permitted in IPAs provided anglers bring their bait with them to the site. IPAs are located between areas of unprotected rock platforms, to allow anglers to collect bait locally. Enforcement is carried out by NSW Fisheries

Officers, supplemented by support from several Local Government or Council rangers who have limited authority to enforce IPAs under the Fisheries Management Act. The latter are involved in management as a result of local ratepayers' and Council concerns over IPAs within their local jurisdictions.

Sydney University undertook a three year study into the effectiveness of IPAs in the Sydney Region, following their protection in 1993 (Chapman and Underwood 1997). The study did not identify any changes in abundance or size-frequencies of populations of particular species, nor changes to the mid- and low-shore assemblages that could be attributed to protection of these populations in IPAs. Collection of animals in the two IPAs examined and public knowledge about IPAs did not improve during the study. Evidence was that the IPAs were ineffectively protected. Declaration of an IPA made no difference to the numbers of people foraging and taking bait, nor to the numbers who knew that this was no longer allowed. There was no public education apart from the few small signs in the IPAs. Provision of inspection or surveillance of IPAs by NSW Fisheries did not appear to be effective, possibly due to lack of resources. The overall conclusion was that those who use the rocky shores as places to kill animals for bait and food were not treating IPAs as protected areas. The main reason for the failure of the IPAs was considered to be the result of limited, if any, enforcement and education effort by NSW Fisheries.

A.II.6.4 Community education

One local Council in the Sydney area developed a successful way of informing the community about the need for IPAs and the role of intertidal habitats, and spread its message to other local government areas. "*Project AWARE on the Rocks*" involves training a group of interested community members about intertidal issues in return for them conducting 20 hours of community outreach work. NSW Fisheries provides written resource materials and gives formal talks to the volunteers. At no time are the volunteers involved in policing or enforcement of the regulations but are involved primarily in the education of the local community about the local intertidal environment. The group has also identified the origins of many of the ethnic harvesters in the Sydney Region and is conducting programmes to reach these communities.

The success of the IPAs and aquatic reserves is very much reliant on the attitudes and support of the local community (which is dependent on education) and the availability of resources to make sure that these areas are successful. If the public are made aware of the reasons for closing or protecting certain areas of the coast and are involved in the process of identifying potential areas they are more supportive of any measures that are taken to ensure that protection is implemented. The more successful IPAs are generally located in local government areas where local residents and the local council support protection of the local intertidal environment, rangers assist with enforcement, and NSW Fisheries officers are located sufficiently close to deal with any breaches of the regulations.

Apart from the issue of ethnic harvesters, the other main source of opposition over aquatic reserves and IPAs is recreational anglers' perception that they are being targeted by fisheries managers trying to dictate where they can and cannot fish. Commercial fishermen only become concerned where their fisheries are conducted in the subtidal region immediately adjacent to intertidal areas. There is a perception that environmental designations may be a token effort to appease certain lobby groups and members of the public. This may be overcome if the closures are either permanent, or given sufficient resources and commitment to ensure that they work effectively.

Acknowledgements: The above information was provided by Michelle Perry, New South Wales Fisheries, Sydney, Australia.

A.II.7 Maine bloodworm and sandworm fishery, USA

Creaser *et al*. 1983 describe the history of the development of this bait worm fishery, possibly the best documented in the world, and worm habitats, digging methods, packing media, and markets. Much of the following information was taken from this document and will, therefore, be slightly out of date. Information on regulations and landings is current.

The first recorded commercial worm fishery on the US Atlantic coast was taking place on Long Island, New York State, by the early 1920s, supplying bait to party boats. Sandworms *Nereis virens* were the first species taken, but bloodworms *Glycera dibranchiata* were soon being harvested as well. The fishery had extended to several other states by the 1930s, but was still not meeting market demand. Possible reasons for this lack of supply included several familiar arguments:

an initial lack of abundance and complaints from landowners objecting to digging in their beaches;

overdigging and depletion of known stocks;

increased demand in sports fisheries;

a decline due to increased pollution from heated effluent discharge and toxic heavy metals; and

a demise in the fishery due to increasing water temperatures.

Abundant worm resources were found in Maine in 1933, and by 1937 the industry was sufficiently well-established for the Maine Legislature to institute ‘control’ legislature. Nearly 40 laws were passed between 1937 and 1955, prohibiting non-residents from digging worms within the boundaries of various municipalities. All were repealed in 1955, when it was discovered that they were motivated by property owners wishing to prevent trespass rather than conserve stocks. By this stage a worm fishery was also established in Canada and importing worms to the USA.

The State of Maine Department of Marine Resources licenses worm diggers and worm dealers. Only individual residents are eligible for a worm digging licence, which costs US $ 43. All revenues from these licences are paid into the Marine Worm Fund (this generates about US $ 46,000 annually and is used to carry out research related to worms, the industry, its restoration, development and conservation). It is unlawful to take or possess more than 125 worms in a day without holding either a marine worm digger’s licence or a marine worm dealer’s licence. Additionally, marine worms may only be taken by ‘devices or instruments operated solely by hand power’, and it is illegal to dig worms commercially on Sundays. Enforcement of these and (other fisheries) rules and regulations is limited by the capacity of the 47 State Marine Patrol Officers to patrol 3,500 miles of coastline, and identification of unlicensed commercial diggers complicated by the existence of the 125 marine worm personal bag limit.

Each marine worm dealer is required by legislation to submit monthly reports (by the tenth day of the following month) of their marine worm purchases and sales. These are completed on standard Department of Marine Resources forms. They must contain purchase details (dates of each purchase of worms, the quantity purchased, the name of individual from whom the worms were purchased and information whether that person is a marine worm dealer); and sales information (dates, quantities of worms sold and name of person to whom sold). No data exist providing information on exports. The Maine worm fishery was one of the top five commercial fisheries (landed value) in the late 1970s, when fewer than 1,200 licensed diggers landed worms worth over US $ 1 million. More recent landings data are provided below.

Table A.II.7(a). Landings of bloodworms *Glycera dibranchiata* from Maine, 1980-1997 (data provided in personal communication from National Marine Fisheries Service Fisheries Statistics & Economics Division – NMFS web site).

Year	**Landings** (metric tons)	**Value (US $)** at first sale
1980	209.4	1 404 222
1981	198.2	1 394 341
1982	297.9	1 962 712
1983	263.3	2 463 415
1984	252.1	1 878 826
1985	249.7	1 882 636
1986	240.6	2 087 210
1987	245.9	2 404 139
1988	181.5	1 932 865
1989	202.8	2 233 164
1990	224.0	2 685 408
1991	219.3	2 456 587
1992	216.9	2 431 139
1993	214.1	2 447 724
1994	243.9	2 796 184
1995	174.5	2 077 334
1996	147.0	1 757 221
1997 *	175.7 *	2 131 731 *

(*Preliminary data and subject to change.)

Table A.II.7(b). Numbers and values (US $ paid to bait diggers) of bloodworms *Glycera dibranchiata* and sandworm *Nereis virens* landed in Maine, 1981-1993 (data provided by E. P. Creaser pers. comm.).

Year	**Licensed worm diggers**	**Bloodworms *Glycera dibranchiata***		**Sandworms *Nereis virens***	
		Numbers	**Value US $**	**Numbers**	**Value US $**
1981	988	19 228 176	1 394 340	29 783 840	1 235 706
1982	943	28 894 624	1 962 712	31 194 760	1 248 808
1983	854	24 662 836	2 463 415	29 039 680	1 167 041
1984	921	24 454 716	1 878 826	26 561 600	1 069 135
1985	939	24 224 596	1 882 636	25 374 800	1 021 061
1986	837	23 339 976	2 087 210	21 339 480	924 448
1987	809	23 854 248	2 404 139	19 949 760	970 462
1988	801	17 606 116	1 932 865	18 338 520	916 942
1989	791	19 670 596	2 233 164	19 050 480	1 009 749
1990	863	21 728 124	2 685 408	20 426 760	1 239 837
1991	840	21 270 832	2 456 587	19 763 360	1 189 773
1992	792	21 043 616	2 431 139	16 467 720	971 129
1993	832	20 769 672	2 447 724	16 424 880	1 005 814
1994	814	23 654 136	2 796 184	13 888 240	1 008 884
1995	886	16 926 448	2 077 334	9 002 240	794 405
1996	999	14 260 092	1 757 221	6 929 360	651 526
1997	1,028	17 044 456	2 131 731	4 147 320	373 508

Licensed worm diggers take only one species or the other of worms, using specially contructed worm hoes made from adapted garden forks. They sell their catch to licensed worm dealers, who pack (using weed provided by seaweed gathers) and ship live worms by refrigerated truck, bus or airfreight to wholesale distributors. Distributors sell to retail outlets, who divide shipments and sell worms by the dozen to recreational fishermen. Creaser *et al*. 1983 report that a market in California had relatively recently begun to take worms, and the most recent market developed was in France. Both species are required in France, but 90% of shipments are of the more highly priced bloodworm *Glycera dibranchiata*. These shipments are all of live worms.

Such detailed information is only available because the Maine legislation requires these data to be submitted, and uses its licence fees for monitoring, management and conservation purposes. The data suggest that the bait worm fishery in the UK is also of huge value, and might also benefit from improved management and regulation were it possible to legislate in the UK in a similar way.

Acknowledgements: The above information was provided by Ted Creaser and Chris Finlayson, Maine Department of Marine Resources, USA.

A.II.8 Ireland

Ireland (north and south) is reportedly a source of a significant quantity of the wild-caught bait imported to the UK. Most of this is dug from east coast estuaries. There are currently no regulations for the collection of bait, but the subject has been raised in connection with the management of marine SACs and SPAs in Ireland. National Parks and Wildlife, Duchas, the Heritage Service, report that the ‘harvesting by hand of sea urchins, winkles and other marine invertebrates’ within designated sites has been proposed as a Notifiable Action. If implemented, this would mean that written permission would be required from the Minister before such operations could be undertaken. The Department of the Marine and Natural Resources has determined that a foreshore license would be required for mechanical harvesting of bait worms. No such harvesting currently takes place. Efforts to control the collection of sea urchins under marine fisheries legislation have run into difficulties in the past because Irish marine legislation does not include echinoderms within its definitions of marine fish and shellfish.

Acknowledgements: Liz Sides, National Parks and Wildlife, Duchas, the Heritage Service, and Dan Minchin, Marine Institute, Fisheries Research Centre, Dublin.

Appendix III

Literature Review – summaries and synopses

Brief synopses of relevant sections of many published and unpublished papers concerning shoreline species collection are given below. The author has obtained not all those listed; some are difficult to source, and others were only identified at the end of the contract because they are referred to in the recent study of Quigley and Frid (1998). The section is intended to provide a more detailed guide to the literature than can be provided by a simple list of citations.

Reference	**Summary of relevant contents**
Addessi, L. 1994. Human disturbance and long term changes on a rocky intertidal community. *Ecological Applications* 4(4): 786-797.	Found a significant positive correlation between the number of inverted rocks and human activity on a shore. Density of all species was reduced in the most heavily visited areas.
Anderson, F.E. & McLusky, D.S. 1981. Physical recovery of an intertidal area disturbed by baitworm harvesting. *Report to Natural Environment Research Council. Ref GR 3/4061*, p. 1-52.	One of two studies on recovery of sediments after bait digging in the Firth of Forth (also see McLusky *et al*. 1983). Examined recovery of areas where bait digging had been simulated, comparing ‘spoil and trench’ digging with infilling. A series of holes were dug, and microtopography, sediments in suspension and surface sediments were monitored for 30 days.
Anderson, F.E. & Meyer, L.M. 1986. The interaction of tidal currents on a disturbed intertidal bottom with a resulting change in particulate matter quantity, texture and food quality. *Estuarine, Coastal and Shelf Science,* 22, 19-29.	Studied surface and suspended sediments after clam digging in Maine, USA.
Anon. 1995 (or 1996?) Angling in the Medina Estuary. Topic report by the Isle of Wight Division of the National Federation of Sea Anglers.	Compiled in response to a request for information by the Centre for Coastal Zone Management, Portsmouth University. Describes nature and location of angling and bait digging activity and a survey of the Medina shore. Comments on CZM options. Prefers voluntary management options and notes that promotion of the NFSA Code of Practice needs most attention (only 1,200 of 5,000 anglers on the Island are NFSA members).
Arnold, J.B. and Arnold, W.B. 1985. Bait digging on the northern shore of Poole Harbour: April - November 1985: A preliminary study of six sites. Unpublished report to NCC, Dorset.	General account of broad impacts of activity in Poole Harbour. The authors refer to bait beds being completely dug out by itinerant groups of commercial baitdiggers from outside the area.
Arnold, J.B. and Arnold, W.B. 1987. Bait digging on the northern shore of Poole Harbour: April - October 1986. Follow-up studies of six sites. Unpublished report to NCC, Dorset.	Follow up of above.
Babbs, S. and Ravencroft, N. 1998. Bait digging on the Stour and Orwell Estuaries. Report to English Nature NB/T/404/97-98.	Numbers and impacts of bait diggers assessed over autumn and winter of 97/98 through counts, questionnaires, circulars and literature searches. Overall the estuaries were not dug heavily, but obvious signs of digging impacts were visible in the most heavily used areas. Physical impacts of digging and potential effects of invertebrate populations were main management issues. Need for management was assessed. Considered first option should be for baitdiggers to set up their own means of policing a voluntary code of conduct, but if no progress is made control is recommended. Options include permits and wardening at key points. Total ban not considered acceptable or necessary. A Working Group is to be set up to consider the report.
Bass, N.R. 1970. Aspects of the ecology, behaviour and life history of the polychaete *Nereis virens*. Unpublished PhD Thesis. University of London.	Not reviewed.
Bass, N.R. and Brafield, A.E. 1972. The life-cycle of the polychaete *Nereis virens. J. Marine Biol. Ass.* 52: 701-726.	Not reviewed.
Bell, D.V., Odin, N., Austin, A., Hayhow, S., Jones, A., Strong, A., and Torres, E. 1984. The impact of anglers on wildlife and site amenity. Department of Applied Biology, UWIST, Cardiff.	Examined impact of boulder turning for peeler crabs. Up to 90% of all boulders in a shore transect at Mumbles Head, Swansea, could be turned within a two week period and some boulders may be turned 40-60 times during the summer. Most boulders (60%) are not replaced in their original position. Larger boulders which are upended and not overturned completely are more likely to be left as they were found.

Beukema, J.J. 1995. The long-term effects of mechanical harvesting of lugworms on the zoo-benthos community of a tidal flat in the Wadden Sea. *Netherlands Journal of Sea Research*. 33(2): 219-227.	Reports on a long-term study of a 1 km^2 area. A near doubling of annual lugworm mortality rate resulted in a gradual and substantial decline of local lugworm stock from more than twice the overall mean at the start of the four year digging period. Total zoobenthos biomass fell even more because the population of the large bivalve *Mya arenaria* that initially comprised half of the total initial biomass was almost completely removed. *Heteromastus filiformis* was the only shortlived species to show a clear population reduction during dredging. Recovery of the benthos took several years, mainly because of the slow re-establishment of a *Mya* population with a normal size and age structure.
Beukema, J.J. and Vlas, J. de 1979. Population parameters of the lugworm *Arenicola marina* on the tidal flats in the dutch Wadden Sea. *Netherlands Journal of Sea Research*, 13, 331-354.	Not reviewed.
Bishop, G.M., Holme, N.A., and Harvey, R. 1980. Survey of the littoral zone of the coast of Great Britain. Final report. Part I. The Sediment Shores. Part II. The Rocky Shores. An assessment of their conservation value. Marine Biological Association and Scottish Marine Biological Association. Report to NCC.	Remarks on strong evidence of a marked deterioration in the richness of some shores since the late 19^{th} century, particularly of marine algae at classical sites in the Southwest, heavily used by classes, and of some invertebrates collected for food, bait, or ornaments.
Blake, R.W. 1977. The exploitation of *Nereis virens* and *Arenicola marina* on the northeast coast of England.	Unpublished PhD Thesis. University of Newcastle-upon-Tyne. See two publications below.
Blake, R.W. 1979 a. Exploitation of a natural population of *Arenicola marina* (L.) from the north-east coast of England. *Journal of Applied Ecology,* 16, 663-670.	Bait diggers usually removed only about 70% of the worms present. Studies of the recovery of lugworm beds experimentally dug out at Whitley Bay indicated that complete recolonisation occurred after one month.
Blake, R.W. 1979 b. On the exploitation of a natural population of *Nereis virens* Sars from the north-east coast of England. *Estuarine and Coastal Marine Science*, 8, 141-148.	Studied exploited and unexploited populations of king ragworms for one year on the north-east coast of England. Population densities were not significantly different, at about 15/m^2 in summer and 3/m^2 in winter, indicating that the dug population (most heavily exploited in summer) was probably not threatened by bait digging.
Brafield, A.E. and Chapman, G. 1967. Gametogenesis and breeding in a natural population of *Nereis virens*. *JMBA UK* 47, 619-627.	Not reviewed.
Broad, G. 1997. An investigation of the ecological effects of harvesting cockles (Cerastoderma edule L.) by hand raking on the intertidal benthic communities in the River Dee estuary, North Wales. MSc thesis, School of Ocean Sciences, University of Wales, Bangor.	Studied the effects of disturbing the ecological balance of intertidal communities through the hand raking of cockles. Signs of recovery wer seen after 2.5 months in small treatment plots, but not large ones. Observed changes in community structure were probably due to release of sulphides, destruction of diatom/bacterial layer, tubes and burrows within and on the sediment surface, and interference with normal predator/prey relationships. Time to recovery was similar to that found for mechanical harvesting impact, but considered to be less destructive to bait digging, particularly to the resident cockle population.
Brosnan, D.M. and Crumrine, L.L. 1994. Effects of human trampling on marine rocky shore communities. *J.Exp.Mar.Biol.Ecol*. 177: 79-97.	Describes an experimental trampling regime. Upper shore trampling resulted in a significant decline in foliose algal species and the crushing and removal of barnacles. Patches caused by trampling in mussel beds continued to enlarge after trampling ceased and had still not recovered two years later. Overall, community structure shifted towards domination by algal turf species with fewer mussels.
Brown, B. and Wilson, H. Jr. 1997. The role of commercial digging of mudflats as an agent for change of infaunal intertidal populations. Journal of Experimental Marine Biology and Ecology. 218: 49-61.	Not obtained.
Cadee, C.G. 1977. Het effect van pierenspitten op de worm *Heteromastus. Waddenbulletin,* 12, 312-313.	Reports an 85% population decline of the polychaete *Heteromastus filiformis*, a common sediment shore invertebrate, after hand digging for lugworms.
Cadman, P.S. 1989. Environmental impact of lugworm digging. Report to the Nature Conservancy Council. Marine, Environmental and Evolutionary Research Group, University College of Swansea. CSD Report Number 910.	One of several studies in South Wales of the impact of hand digging for worms on other populations of sediment shore habitats and common invertebrates and their recovery. Compared effects of trench digging with use of bait pumps on lugworm population recovery and effects on other spp. Not obtained for this study.
Cadman, P.S. and Nelson Smith, A. 1990. Genetic evidence for two species of lugworm *Arenicola* in	Not reviewed.

South Wales. *Marine Ecology Progress Series.* 64, 107-112.	
Cadman, P.S. and Nelson Smith, A. 1993. A new species of lugworm *Arenicola defodiens* sp. nov. *J.Mar.Biol.Ass.UK.* 73(1) 213-224.	Confirms that the 'blacklug' described by anglers is a new species. Appears to prefer the bottom of more exposed sandy shores.
Cadman, P.S. Studies on lugworm *Arenicola.* MSc Thesis.	Not reviewed.
Caron, C., Boucher, L., Desrosiers, G., & Retiére, C. 1995. Population dynamics of the polychaete *Nephtys caeca* in an intertidal estuarine environment (Quebec, Canada). WHAT JOURNAL? 75, 871-884.	Refers to the longevity of the species – one individual of 15 years old sampled. Reference obtained from internet – journal still to be identified.
Castilla, J.C. and Duran, L.R. 1985. Human exclusion from the rocky intertidal zone of central Chile: the effects on *Concholepas concholepas* (Gastropoda). *Oikos* 45: 391-399.	Comparison of open and restricted access shores indicates that a increase in numbers of the loco *Concholepas concholepas* (a carnivorous gastropod) as a result of a harvesting ban resulted in a decrease in a competitively dominant intertidal mussel which suffered from increased predation pressure from the gastropod. The bare space produced was subsequently colonised by other invertebrates and algae.
Cayford, J. 1993. Wader disturbance: a theoretical overview. In: Davidson, N. and Rothwell, P. Disturbance to waterfowl on estuaries. Wader Study Group Special Issue 68: 3-5.	Reviews work on foraging efficiency, competition and dispersion, which may help to predict effects of disturbance (e.g. by bait collection) on wintering waders.
Chapman, G. and Newell, G.E. 1949. The distribution of lugworms (*Arenicola marina*) over the flats of Whitstable. *Journal of the Marine Biological Association UK*, 28, 627-635.	Not reviewed. *Inter alia*, examined number and size of casts over a one year period from November 1946 to October 1947.
Chapman, M.G. and Underwood, A.J. 1996. Experiments on effects of sampling biota under intertidal and shallow subtidal boulders. *Journal of Experimental Marine Biology and Ecology.* 207: 213-237.	Quoted in Quigley and Frid 1998. Not reviewed.

Chapman, M.G. and Underwood, A.J. 1997. Testing the effectiveness of intertidal protected areas in New South Wales. Final Report September 1997. Institute of Marine Ecology, University of Sydney, NSW, Australia.	In 1993 NSW Fisheries gazetted a number of Intertidal Protected Areas around Sydney. These areas are theoretically closed to foraging and bait collection, although anglers may still fish in them. The project evaluated the effectiveness of IPAs three years after protection started. It found no changes in abundance or size-frequencies of populations of particular species, nor changes to the mid- and lowshore assemblages that could be attributed to protection of these populations in IPAs. Collection of animals collected in the two IPAs examined and public knowledge about IPAs did not improve during the study. Evidence was that the IPAs were ineffectively protected. Declaration of an IPA made no difference to the numbers of people foraging and taking bait, nor to the numbers who knew that this was no longer allowed. There was no public education apart from the few small signs in the IPAs. Provision of inspection or surveillance of IPAs by NSW Fisheries did not appear to be effective, possibly due to lack of resources. IPAs were not treated as protected areas by those who use the rocky shores as places to kill animals for bait and food.
Clark, R.B. 1977. Ecological impact of bait digging. *Report on Pilot Study to the Nature Conservancy Council. CST Report Number 133.*	A desk study commissioned by the Department of the Environment after NERC (1973) noted a potential problem of stock depletion in some areas. It gave a preliminary assessment of the extent and nature of the ecological impact of bait digging by questionnaire survey, examined biological information, and made proposals for further work. Discusses problems of enforcement of regulation by various authorities.
Clark, R.B. 1980. Impact of bait digging on Cleethorpes beach. Cleethorpes Borough Council unpublished report.	(Not seen, but presumably refers to the review commissioned by the Borough Council in connecting with the existing bye law restricting bait digging to only part of the beach for amenity reasons.)
Cleator, B. and Irvine, M. 1995. A review of legislation relating to the coastal and marine environment in Scotland. *Scottish Natural Heritage Review* No. 30.	Summarises the legal and administrative mechanisms employed in the management of the coastal environment in Scotland and draws upon and updates the review of Legislative Responsibilities in the Marine Environment (NCC 1989). Approaches to coastal zone management in various other countries are reviewed and compared with the current situation in Scotland.
Coates, P.J. 1983. Fishing bait collection in the Menai Strait and its relevance to the potential establishment of a marine nature reserve, with observations on the biology of the main prey species, the ragworm *Nereis virens*. MSc report, Centre for Environmental Technology, Imperial College of Science and Technology, University of London.	Studied the slow recovery of bait-dug areas in the Menai Straits. Describes unusual nature of king ragworm population there, a large proportion of which grows to an unusually large size before spawning (also see Olive 1987).
Creaser, E.P. and Clifford, D.A. 1982. Life history studies of the sandworm, *Nereis virens* Sars, in the Sheepscot Estuary, Maine, USA. *Fisheries Bulletin* 80, 735-743.	The species has been of commercial importance in Maine for over 40 years. Study carried out in an area closed to commercial bait digging. Equal numbers of male and female spawners of <30 cm, but large numbers of females >30 cm were found. 30% of largest worms showed no signs of sexual development. Maturation of eggs could take from 12 to 18-20 months. Spawning occurred in April/May, four days after full moon during spring tides and during water temperature of 6-8^{o}C. A 16 cm worm could lay 0.05 million eggs, and a 54 cm worm 1.3 million eggs. Male spawners emerged three hours after high tide.
Creaser, E.P. 1973. Reproduction of the bloodworm (*Glycera dibrachiata*) in the Sheepscot Estuary, Maine. *J. Fish. Res. Board Can.* 30: 161-166.	Population of bloodworms is composed of five assumed year classes. Most spawners are probably large 3- and 4-year olds. Spawning takes place in June (water temperature over 13^{o}C). Males emit streams of sperm while swimming at the surface, and females swim rapidly there, suddenly rupturing and releasing 1-10 million eggs.

Creaser, E.P. and Clifford, D.A. 1986. The size frequency and abundance of subtidal bloodworms (*Glycera dibrachiata*, Ehlers) in Montsweag Bay, Woolwich-Wiscasset, Maine. *Estuaries*. 9(3): 200-207.	Bloodworms were first dug commercially from the area in 1933. Construction of a causeway in 1950 caused extensive areas of former beds to become subtidal. A 1971 study investigated whether the population continued to exist in the subtidal and might provide a source for juvenile recruitment into the heavily dug intertidal beds. The proposed removal of the causeway would result in the beds becoming available again for exploitation. The study estimated that some 6 million ± 3 million worms were present in the submerged area, worth $0.06-0.10 each in 1983.
Creaser, E.P., Clifford, D.A., Hogan, M.J. and Sampson, D.B. 1983. A commercial sampling program for sandworms, *Nereis virens* Sars, and bloodworms, *Glycera dibranchiata* Ehlers, harvested along the Maine coast. *NOAA Technical Report* NMFS SSRF-767. US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.	Covers possibly the best-documented and regulated fishery for bait worms in the world. Describes habitats, digging methods, packing media, and worm markets. Diggers are licensed by the State of Maine Department of Marine Resources. They take only one species or the other and sell their catch to licensed worm dealers, who pack and ship worms to wholesale distributors. Distributors sell to retail outlets, who divide shipments and sell worms by the dozen to recreational fishermen. The fishery was one of the top five commercial fisheries (landed value) in 1976, being worth over US $ 2 million.
Cryer, M. (ed). 1986. Angling and Wildlife. A report of the work undertaken for the MSC during the period May 1985 to May 1986. University of Wales, Institute of Science and Technology.	One chapter studied effects of bait digging and overturning boulders for crab collection in South Wales (Swansea Bay, Barry Harbour and west Aberthaw). See published paper below.
Cryer, M., Whittle, G.N., & Williams, R. 1987. The impact of bait collection by anglers on marine intertidal invertebrates. *Biological Conservation,* 42, 83-93.	Found no significant increase in the density of lugworms in depopulated areas during a six month experimental period. Controls and experimental sites converged in autumn and winter. (Initial densities at these sites were very low, at 9 and 16 worms/m^2 and population growth usually occurs in spring and summer). Authors suggested that timing of collection may be important in determining impact. Recovery from summer and autumn digging is not likely to occur until larval settlement and juvenile and adult migration. Population likely to be protected against exploitation by low efficiency of removal and the large proportion located below low water on most beaches. Boulders sheltering crabs on initial surveys (usually large, porous, irregularly shaped and heavily encrusted) were more likely to yield a crab on subsequent visits, whether or not replaced. When boulders with no crabs were replaced there was a significant increase in the probability of finding a crab under the same boulder on a subsequent visit. Replacing any boulder after searching for a crab significantly increased the probability of finding crabs on a subsequent tide.
Dales, P.R. 1950. The reproduction and larval development of *Nereis diversicolor. J. Marine Biol. Ass.* 29: 321-360.	Not reviewed.
Davidson, N. and Rothwell, P. 1993. Disturbance to waterfowl on estuaries. *Wader Study Group Special Issue* 68: 3-5.	Review of impacts of presence of individuals on the shore and other activities in estuaries on waterfowl numbers. Considers case studies from the Dutch Wadden Sea and Delta area, Denmark, Dee and Exe Estuaries, and a UK shooting disturbance project, and describes the effects of disturbance to waterfowl from bait digging and wildfowling in Lindisfarne NNR (see Townshend and O'Connor 1993, below).
Davis, S. 1993. Bait-digging on Gillan Creek. Report to Manaccan and St Anthony Parish Councils. Unpublished.	Describes effects of increased commercial exploitation of bait beds in the Helford River, Cornwall, where habitat damage from bait digging is visible for several weeks after this activity. Investigates the issues surrounding the use of estuaries for bait digging and how the experiences of other areas may be used to safeguard the future of Gillan Creek and the Helford River. Various management options are suggested for discussion, including education, controls on access, licensing, and Local Nature Reserve designation.

De Potier, A. 1998. Environmental Research for Estuary Management: the Chichester Harbour Approach. Proceedings of a Seminar held on 27 April 1988. Chichester Harbour Conservancy.	The Conservancy carried out an appraisal of the likely pressures in the Harbour in 1992 and invested in a wide-ranging programme of scientific research and monitoring to investigate natural processes and impacts and effects of human activity (including bait digging – see Farrell 1998). The Seminar disseminated the research results.
Dye, A.H. 1992. Experimental studies of succession and stability in rocky intertidal communities subject to artisanal shellfish gathering. *Netherlands Journal of Sea Research* 30: 209-217.	Not reviewed. Cited in Quigley and Frid. Notes that community level parameters such as species diversity or richness do not always result in a predictable fashion to the effects of human predation.
Dyrynda, P. 1995. Impacts of bait dragging on the seabed within Poole Harbour. Report to Southern Sea District Fisheries Committee from the Marine Environmental Research Group, University of Wales, Swansea.	An unusually large population of *Nereis virens* occurs on muddy shores and shoals in the Harbour. Unregulated bait dragging by about 15 vessels occurs on very soft muddy ground that is unsuitable for bait digging. A double-tined fork is dragged through the sediment by a motor vessel, hooking and dragging out large worms. There is concern about the impact of this activity on seabed ecology and privately leased mariculture beds laid with mussels and other shellfish. The report describes results of experimental bait dragging on natural seabed and newly laid *Mytilus edulis* plots. Bait dragging has a smaller impact than bait digging, but is more widespread; carried out across many remote and otherwise undisturbed areas, as well as on the lower shore of beaches also dug by hand. In addition to the removal of large numbers of ragworms, other large infauna are likely to be damaged by dragging, which causes disturbance to a depth of 0.3-0.5 m. If undertaken in these habitats, it would also cause extensive damage to *Zostera* beds, *Sabellaria* (tubeworm) beds and saltmarsh. Mussel aggregations are displaced and disrupted, with some overturned and buried. No evidence of shell damage was recorded.
Dyrynda, P. and Lewis, K. 1994. Sedimentary shores within Poole Harbour: Bait harvesting and other human impacts. Report to English Nature (South-West Region) from the School of Biological Sciences, Swansea University.	Field surveys undertaken at nine locations on the northern shore. Assessments covered habitats and invertebrate fauna, with particular reference to five bait species. Lugworm stocks are substantial, as are kingrag worms. Sustainable commercial yields of the latter appear to be maintained from baitdragging. Catworms (white rag *Nephtys* spp.) may be most vulnerable to overexploitation and there is some evidence for midshore depletion. Some large and fragile non-target infauna (e.g. acorn worm *Saccoglossus horsti*) are considered very vulnerable to baitdigging, as are seagrass *Zostera* and peacock worm *Sabella pavonina* beds when exposed during extreme spring tides. Different shore types recover at different rates, and heavily-dug stony beaches are most seriously affected. Recommendations are made for management and for further studies. Latter included study of impact of bait dragging (see above), impacts of kingrag *Nereis virens* and white rag *Nephtys* digging, and impacts of bait harvesting on bird and fish populations.
Dyrynda, P.E.J. and Brown, F. 1998. Factors affecting condition and mortality of farmed mussels in Poole Harbour: 195-1997. Final report to Southern Sea District Fisheries Committee from the Marine Environmental Research Group, University of Wales, Swansea.	Bait collection not considered.
Emerson, C.W., Grant, J. and Rowell, T.W. 1990. Indirect effects of clam digging on the viability of soft-shelled clams *Mya arenaria*. *Netherlands Journal of Sea Research.* 27(1): 109-118.	Used laboratory experiments to see whether non-lethal burial or exposure on the sediment surface could alter the normal living depth of *M. arenaria* in sand and mud. Clams buried more deeply than normal in sand had not recovered to normal depths after two weeks, and exposed clams on mud had reburrowed to abnormally shallow depths in two weeks. Concluded that the impacts of clam digging are not only removal of market-sized clams and shell breakage of remaining ones. Exposure of pre-recruits may increase susceptibility of unharvested clams to predation, desiccation or freezing, with effects depending on different sediment types.
Evans, J. and Clark, N.A. 1993. Disturbance studies on Swansea Bay and the Burry Inlet in relation to bird populations. BTO Research Report No. 107.	Study carried out in February 1993. Lower numbers of bait diggers were seen than expected (possibly due to time of year). Because beaches between Marina and Mumbles are heavily disturbed they are not used by waders, and the Burry Inlet is an important feeding site. Large numbers of birds, particularly oystercatchers, feed and roost there. Disturbance to feeding and roosting birds (particularly oystercatchers and curlew) by cocklers accessing Llanrhidian Sands was recorded.
Evans, L.J. and Macpherson of Cluny J. 1993.	Summarise judgements over the Budle Bay bait digging prosecution

Anderson v. Alnwick District Council. 1 *Weekly Law Reports.* 1993. Pp 1156-1171.	case history. *Inter alia*, confirmed that the foreshore extends to the limit of the low water line at any time; that there is a public right to take worms from the shore ancillary to the public right to fish in the sea, but this right is not unrestricted (collection for sale is not permitted) and may be regulated in certain areas provided that alternative sources of bait are available reasonably close by. See case study for more details.
Evans, S.M., Arnott, S. and Wahju, R.I. 1994. Evidence of change in the macrofauna of tidal flats subject to anthropomorphic impacts in north-east England. *Aquatic Conservation: Marine and Freshwater Ecosystems.* (4) 333-334.	Study assessed differences that had occurred in macrofaunal assemblages of tidal flats between 1931 and 1991. Dominant members of assemblages were same for both surveys, and almost all taxa recorded in 1931 were present. Two sorts of change were evident: an Arenicola/Scoloplos/Cerastoderma/Macoma community had been replaced by an oligochaete-dominated community in part of Budle Bay, and numerical densities of macrofauna were higher in 1991, both probably the result of eutrophication. Baitdigging had been intense at one site since at least the early 1930s, but both target species (*Arenicola* and *Nereis virens*) still occurred there.
Farke, H., De Wilde, P.A.W.J. and Berghuis, E.M. 1979. Distribution of juvenile and adult *Arenicola marina* on a tidal mud flat and the importance of nearshore areas for recruitment. *Netherlands Journal of Sea Research,* 13 (3/4) 354-361.	Not reviewed.
Farrell, P. 1998. Environmental impacts of baitdigging. In de Potiers, A. 1998. Environmental Research for Estuary Management: the Chichester Harbour Approach. Proceedings of a Seminar held on 27 April 1988. Chichester Harbour Conservancy.	Three year research study carried out because of increased commercial bait digging for king ragworm in the Harbour. Results were needed to support possible introduction of a bylaw. An experimental site was established in a remote location and sediment invertebrates sampled before and after digging. Four species were significantly affected. A large worm *Amphitrite johnstoni* and its commensal *Harmathoe imbricata* were completely absent following digging, and still at very low numbers a year later. Cockle *Cerastoderma edule* numbers fell slightly after digging. Common periwinkle *Littorina littorea* numbers increased – they moved into the area and settled on large flints exposed by digging.
Farrell, P. 1996. The environmental impact of bait digging: effects on the infauna and epifauna of Chichester Harbour. Report for the Institute of Marine Sciences, Portsmouth.	Some local concern about effects of bait digging in the harbour, but no local research had been carried out. This project studied local effects, including areas dug, commercial outlets in the region, and discussions with bait diggers. *Nereis virens* is the main target species.
Fitzpatrick, S., and Bouchez, B. 1998. Effects of recreational disturbance on the foraging behaviour of waders on a rocky beach. *Bird Study.* 45:157-171.	Quoted in Quigley and Frid 1998. Not reviewed.
Flach, E.C. 1992. Disturbance of benthic infauna by sediment reworking activities of the lugworm *Arenicola marina. Netherlands Journal of Sea Research* 30, 81-89.	Not reviewed.
Fletcher, H. 1997. The impact and management of visitor pressure on rocky shore communities. PhD Thesis. University of Newcastle upon Tyne.	Quoted in Quigley and Frid 1998. Not reviewed.

Fletcher, H. and Frid, C.L.J. 1996. Impact and management of visitor pressure on rocky intertidal algal communities. *Aquatic Conservation: Marine and Freshwater Ecosystems.* 6: 287-297.	A trampling study at two sites in Northeast England resulted in reduced abundance of fucoid and turf algal species and increased amounts of bare space in trampled plots. Suggested that changes to algal composition may result from as few as five people walking over the area on each spring tide cycle.
Forbes, A.J. 1984. The bait worm fishery in Moreton Bay, Queensland. Queensland Department of Primary Industries, Project Report Q 084009, pp. 18.	Not obtained.
Fowler, S.L. 1992. Survey of bait collection in Britain. Joint Nature Conservation Committee Report No. 107.	A review of species, community and habitat effects updated by this report. Also describes result of a bait collection survey circulated in 1985 to local authorities (County Councils, District Councils and some Harbour or Ports Authorities), angling clubs, conservation organisations and interested individuals.
Gee, K. 1993. Impact of recreation on the intertidal habitats of the Menai Strait proposed marine nature reserve: an assessment of sustainability. MSc University College London.	Sea angling and bait digging were the recreational activities found to have the greatest impact on intertidal communities. The latter has a widespread impact on the soft shores, particularly ragworm beds, and causes not only a decline in the ragworm population but also associated infauna. It is ultimately considered to be unsustainable in the long term because conditions do not allow quick repopulation of depleted areas.
Ghazanshahi, J., Huchel, T.D. and Devinny, J.S. 1983. Alteration of Southern California Rocky Shore Ecosystems by Public Recreational Use. *Journal of Environmental Management* (16) 379-394.	Describes how visitors can damage rocky shore ecosystems by taking organisms and trampling them underfoot. Usually only a few prominent animals are removed, and populations (including rarities) may increase because of reduced competition by former dominants. Trampling reduces algal populations, with abundant species most heavily affected.
Girvan, J. 1995. Judgement 1995 No. 1114 in the High Court of Justice in Northern Ireland Chancery Division between Thomas Adair (plaintiff) and the National Trust and the Crown Estate Commissioners (Defendants).	Confirmed the right of the plaintiff and others to collect winkles and whelks from the waters, bed and foreshore of Strangford Lough, and the right to collect worms related to an actual or intended right to fish, but not for commercial resale. More details in Strangford Lough case study.
Godden, N.R.S. 1995. Crab trapping in the South Devon Estuaries (primarily around Plymouth). Honours Project submitted in partial fulfilment of the requirements for the degree of BSc. Plymouth University Institute of Marine Studies.	Investigates the trapping of crabs using guttering and tiles in the south Devon estuaries, primarily around Plymouth. Numbers have grown from none to 8,750 traps at Plymouth, and increased 10-fold in the Exe and Teign estuaries. Commercial collectors supply local angling shops and outlets elsewhere. Natural crab populations fluctuate yearly, seasonally and daily, and larval planktonic stages allow recolonisation of depleted areas. Extent of depletion is therefore hard to prove. Increased fishing effort also provides sanctuaries for marine animals and plants at low tide, and sources of food for fish and birds.
Goss-Custard, J.D. and Verboven, N. 1993. Disturbance and feeding shorebirds on the Exe Estuary. *Wader Study Group Bulletin.* 68: 59-66.	Not obtained.
Grant, J. 1981. Sediment transport and disturbance on an intertidal sandflat: infaunal distribution and recolonization. *Marine Ecology - Progress Series*, 6, 249-255.	Not reviewed.
Hall, S.J. and Harding, M.J.C. 1998. The effects of mechanical harvesting of cockles on non-target benthic infauna. *Scottish Natural Heritage Research, Survey and Monitoring Report* No. 86.	Describes result of three year study in Auchencairn Bay, Solway Firth. Preliminary survey was followed by two manipulative field experiments on suction dredging and tractor dredging. Suction dredging effects were statistically significant, but recovery had occurred by 56 days after dredging. The effects of tractor dredging were not statistically significant, but this was likely because the experiment was carried out at a different time of year. Concluded not possible to make a distinction between the effects of the two methods, recovery from both is rapid, and overall effects on populations low.
Havard, M.S.C. and Tindal, E.C. 1991. The impacts of bait digging on the polychaete fauna of the Swale Estuary, Kent, UK. *Polychaete Research* 16, 32-36.	The impact of bait digging was investigated by measuring digging activity and species affected. It was estimated that 6.5% of *Arenicola marina* (main target species) were removed annually (4,300 worms per day or over 1.5 million per year – probably an underestimate). Recovery was measured in experimental dug plots. After digging there was an immediate loss of invertebrates, both the target bait species and other species disturbed in the digging process. Dug areas were recolonised over a period of some months. After six months (January to July) *A. marina* in the experimental dug plots had only recovered to 21% of control site numbers. Other species, e.g. *Scoloplos armiger*, returned to 78% of original levels within the

	period. This level of exploitation gives rise to some concern as to the sustainability of the activity. Bait diggers need a permit to dig in the Swale Local Nature Reserve. Only five of 841 bait diggers approached by wardens during a six week period in 1984 had valid licenses. The majority claimed ignorance of the designated conservation area and the need for a license.
Heiligenberg, T. van den. 1987. Effects of mechanical and manual harvesting of lugworms *Arenicola marina* L. on the benthic fauna of tidal flats in the Dutch Wadden Sea. *Biological Conservation*, 39, 165-177.	Studied effects of both hand and mechanical digging on habitats, lugworm populations and other sediment infauna. Monitoring of the fauna of dredged sites was carried out for six months. (The rate of physical recovery of the sediment surface is not recorded.) Hand digging caused a significant reduction in many of the common species, including *Scoloplos armiger, Nereis diversicolor, Heteromastus* and, of course, *Arenicola* (50% removal). A total of 1.9 g of other benthic animals were removed for every 1 g of *Arenicola*. Mechanical digging has a much more serious effect, with complete removal of *Arenicola* and up to an 80 or 90% loss of the Baltic tellin *Macoma baltica, Scoloplos* and *Heteromastus*. Using this method, for every gram of lugworm taken, 9 to 13.4g of other invertebrates are removed from the area. Dredges strain sediment through a sieve with water jets, leaving gullies 40cm deep and one metre wide, bordered on each side by a 1.5 metre wide ridge a few cm high. They usually only operate within a very large area of intertidal sand flat, and are likely to leave considerable areas untouched.
Herwerden, L. van. 1989. Collection of mussel worms *Pseudonereis variegata* for bait – a legislative anachronism. *South African Journal of Marine Science*, 8, 363-366.	Not obtained.
Hockey, P.A.R. 1987. The influence of coastal utilisation by man on the presumed global extinction of the Canarian black oystercatcher *Haematopus meadewaldoi* Bannerman. *Biol. Cons.* 38, 49-62.	Considers that one of the factors that could have contributed to the extinction of this species may have been intensive exploitation of intertidal organisms. The limpet *Patella canedei* is still locally extinct as a result of this activity.
Hockey, P.A.R. and Bosman, A.L. 1986. Man as an intertidal predator in Transkei: disturbance, community convergence, and management of a natural food resource. *Oikos* 46, 3-14.	Proposed that human collecting activities on sessile filter feeders, grazing and predatory gastropods provided a form of non-selective intermediate disturbance that resulted in an increase in species diversity in harvested areas.
Howell, R. 1985. The effect of bait digging on the bioavailability of heavy metals from surficial intertidal marine sediments. *Marine Pollution Bulletin*, 16, 292-295.	Records increased levels of heavy metals found in surface sediments and invertebrates following intensive bait digging in Budle Bay. Estimated that the weight of sediment turned over by 50 diggers was 62.5 tonnes. The exposure and subsequent oxidisation of deep sediments by digging enables heavy metals (cadmium and lead) which are bound to sediment particles in reduced (anoxic) conditions to become bioavailable. Cadmium is also concentrated in the anoxic layers by the activity of lugworms; their removal therefore exacerbates this problem.
Huggett, D. 1992. Foreshore fishing for shellfish and bait. RSPB.	Considers cockle fishing and bait worm collection by hand and dredge. Summarises legal aspects of foreshore fisheries (ownership of foreshore, access etc.), life histories of target species, and impacts of bait digging by hand and by mechanical lugworm diggers.
Huggett, D. 1995a Coastal zone management and baitdigging: A review of potential conflicts with nature conservation interests, legal issues and some available regulatory mechanisms. In: *Management techniques in the coastal zone*. Proceedings of the Conference organised by the University of Portsmouth, October 24-25, 1994.	Extremely useful review of the legal status, management and potential for regulation of bait digging.
Huggett, D. 1995b. A review of coastal zone management powers. A response to the Department of the Environment's review of byelaw making powers in the coastal zone. Royal Society for the Protection of Birds, August 1995.	The difficulty of achieving effective control of bait collection is one of the issues discussed in this document. *Inter alia*, it examines restrictions in byelaw purposes, constraints on the operation of voluntary agreements and causes of failure, legislative constraints, conflicts in duties, functions and powers, and the problem of public rights and third party activities. Several case studies are described.
Hunter, E. and Naylor, E. 1993. Intertidal migration by the shore crab *Carcinus maenus*. Marine Ecology Progress Series. 101: 131-138.	Quoted in Quigley and Frid 1998. Not reviewed.

Jackson, M.J. & James, R. 1979. The influence of bait digging on cockle, *Cerastoderma edule*, populations in north Norfolk. *Journal of Applied Ecology*, 16, 671-679.	Suggest that intensification of commercial digging for bait worms on the North Norfolk coast in the 1950s and '60s resulted in a decline in cockle *Cerastoderma edule* populations. Undisturbed cockle beds were not affected. Cockles were thought to be killed by burial by bait digging, because they cannot regain their normal position at the surface of the sediment if deeply buried in overturned spoil. Authors estimated that a bait digger turns over 6-12m^{-2} of sand in a tide, or 25-50 acres per year on the north Norfolk sands.
James, R. Perrow, M.R. and Thatcher, K. 1993. The effects of bait digging on the benthic fauna of intertidal flats. No publication information.	Influence of bait digging on marine benthic invertebrates determined by field and laboratory experiments. Infauna sampled in experimentally dug plots and adjacent controls at two sites in eastern England from January to March 1990. *Arenicola marina, Nephtys caeca, Lanice conchilega, Cerastoderma edule* and Nematode densities were significantly reduced by digging; *Macoma balthica, Ostracoda, Harpacticoida* and Foraminifera densities were not. Laboratory experiments demonstrated the mobility and resistance of *Macoma* to burial, and vulnerability of *Cerastoderma*.
Johnson, G. 1984. Bait collection in a proposed marine nature reserve. MSc Report, Ecology and Conservation Unit, University College London.	Continued study by Coates 1983. Describes methods of bait collection of peeler crab, lugworm and king ragworm, and distribution and numbers of bait collectors in the Menai Strait. Disturbance found to be widespread, but particularly intensive within the ragworm beds (where 30-50% of most popular areas were disturbed each year) and in virtually all suitable areas for moulting crab (where 70-90% of rocks showed signs of being displaced). Studied the recovery of bait dug areas in very sheltered conditions, where bait digging results in the movement of underlying boulder clay to the surface. Some experimental plots were still visible one year after having been dug, and all holes dug during the season were still present at the end of the season.
Johnston, J. 1991. Impact of bait digging on the wintering birds of Spurn Bight. English Nature Report.	Compares trends in number of wintering birds in the study area, where bait digging is common, with national trends. Desk Study.
Jones, A. 1992. An assessment of the implications of bait digging for the nature conservation interests of the Welsh shore of the Severn Estuary/Bristol Estuary. CCW South Wales Report CCW/SW/12.	Established extent of bait digging on the Welsh shore of the Severn Estuary through direct observations (at Burry Inlet, Sully Island and Cardiff foreshore), contacts with bait diggers, retail fishing outlets, and local organisations. Species collected included lugworm, king ragworm, razor shells and peeler crab. Sales of lugworm and ragworm in local shops varied from 1 to 100 lbs per week. All sources indicated that lugworm was in decline on the Welsh coast. Decline in birds using Swansea Bay attributed by observers to bait digging.
Kaiser, M.J. and Pickett, G. 1996. The effects of fishing on the marine environment. Intertidal fisheries paper for EN/MAFF workshop.	Lists main effects as: 1) physical disturbance of the sediment, 2) direct removal or death of non-target organisms, 3) transport of contaminants and heavy metals at the sediment surface, 4) sediment resuspension, and 5) localised reduction in food for birds and other predators. Considered collection of lugworm, king ragworm and premoult green crabs. Reviews much of the same literature covered here.
Keough, M.J., Quinn, G.P., and King, A. 1993. Correlations between human collecting and intertidal mollusc populations on rocky shores. *Conservation Biology* 7(2): 378-390.	Quoted in Quigley and Frid 1998. Not reviewed.
Kingsford, M.J., Underwood, A.J., and Kennelly, S.J. 1991. Humans as predators on rocky reefs in New South Wales, Australia. *Marine Ecology Progress Series*. 72: 1-14.	Quoted in Quigley and Frid 1998. Not reviewed.
Langton, A. 1994. Report to the Secretary of State for the Environment on a Public Inquiry held at the Guildhall, Berwick-upon-Tweed, March 1994.	Provides a useful background to the history of bait digging controls at Budle Bay, Lindisfarne National Nature Reserve (NNR), the approval of the Section 29 Order and amendment of the NNR byelaws prohibiting bait digging in the Bay. See case study for more details.
Latus, J.E. 1993. A study into the exploitation of *Arenicola marina* L. on the River Camel (North Cornwall). No publication details.	Regional English Nature Report? Not obtained for review.
Liddiard, M., Gladwin, D.J., Wege, D.C. and Nelson-Smith, A. 1989. Impact of boulder-turning on sheltered sea shores. Report to the Nature Conservancy Council. School of Biological Sciences, University College of Swansea. NCC CSD Report 919.	Authors suggest that a minimum of 3,000 rocks were overturned daily during periods of reasonably low tides at both Mumbles and Oxwich. An unknown proportion involve the repeated overturning of the same rocks. No 'serious' collector was seen to replace rocks in their original position. The chief result of this damage to rocky shores is the loss of habitat stability, which in turn seriously affects the range of species

	found on and beneath boulders. The removal of large algae will also cause the destruction of their understory habitats, which are important for the shelter provided to small algae and invertebrates.
Litten, J.M. 1993. A study of *Arenicola marina* and the environmental impact from their exploitation as a sea angling bait. BA (Hons) study. Coleg Normal Bangor.	Examined life-cycle of lugworm and environmental impacts of harvesting on their populations, habitat and non-target species by literature review and studies in Red Wharf Bay and Benllech Bay, Anglesey. Recovery of the sediment after digging on the high-energy beach of Benllech Bay was less than 7 days, but longer than this at Red Wharf Bay.
Lynch, P. and Prokop, F. 1993. Intertidal invertebrates – Regulations. *NSW Fisheries Fishnote* DF/28, July 1993.	Introduced reduced bag limits for intertidal species collection, permitted harvesting methods, and declaration of protected areas where no harvesting may take place. Fines of up to $10,000 apply for breaching NSW Fisheries regulations.
McKay, D.W. and Fowler, S.L. 1997 a. Review of the exploitation of the mussel *Mytilus edulis* in Scotland. *Scottish Natural Heritage Review.* No. 68.	Collection of mussels for food and bait has been undertaken in Scotland since prehistoric times. Catches have been recorded since 1886, and have declined significantly over the past 100 years. Mussels were collected by hand prior to 1986, and by mechanical dredging since 1986. In 1994 mussels were the seventh most important shellfish in terms of weight landed and 12th in terms of value. Most natural mussel beds yield mussels only suitable for processing. A questionnaire circulated to Scottish Natural Heritage and Scottish Fisheries Protection Agency Staff reported only a small amount of collection of mussels for personal use (table or fishing bait), and commercial collection. There is no right of public fishery for mussels in Scotland, but it is probably a tolerance. The environmental role of mussels in the natural environment is considered. They provide an important habitat for other invertebrates, and a food source for birds and feeding fish. Compared with commercial mussel collection, the impacts of hand collection are considered to be small, although unstudied in the UK.
McKay, D.W. and Fowler, S.L. 1997 b. Review of Winkle *Littorina littorea* harvesting in Scotland. *Scottish Natural Heritage Review.* No. 69.	Collection of winkles for food has been undertaken in Scotland since prehistoric times. In 1994 winkles were the sixth most important shellfish in terms of weight landed and 7th in terms of value according to official landings statistics. This is almost certainly a considerable under-estimate – exports are probably twice this. Habitat damage (chiefly by stone turning and disturbance to algae) and habitat and community change (caused by removal of an important herbivore) is briefly reviewed, as are impacts on winkle populations and shore birds and mammals. Collection will cause depletion of winkle populations, but has little permanent effect because it targets the largest individuals that are frequently no longer contributing to recruitment due to infestation by parasitic flukes.
McLusky, D.S., Anderson, F.E. & Wolfe-Murphy, S. 1983. Distribution and population recovery of *Arenicola marina* and other benthic fauna after bait digging. *Marine Ecology - Progress Series,* 11, 173-179.	The process of digging for bait causes the death of many other marine invertebrates, by physical damage, burial and smothering or exposure to desiccation and predation. Recovery of dug areas takes place most quickly (within three weeks) where holes and trenches are back filled (McLusky *et al*. 1983), and in the most wave-exposed areas. Rapid recolonisation by *Arenicola* is thought to occur by above surface migration in response to enhanced organic matter levels in the soft microhabitat of the trenches. Bait digging did not pose a significant threat to spawning stock of lugworms.
Mitchell, A. 1995. The effect of bait digging on the intertidal macrofauna of the Stour and Orwell estuaries. Suffolk Wildlife Trust.	Compared densities, biomass and distribution of species in areas with and without digging.
Natural Environment Research Council. 1973. *Marine wildlife conservation. NERC publications Series B, No. 5. NERC.*	Noted bait digging was a potential problem in some areas.
Nature Conservancy Council & Natural Environment Research Council. 1979. *Nature conservation in the marine environment.* Report of the NCC/NERC Joint Working Party on Marine Wildlife Conservation. NCC.	Identified 'strong evidence of damage to sandy and muddy beaches by bait-digging.' Reported that the National Anglers Council estimated in the 1970s that about 75% of anglers prefer to dig their own bait.
New South Wales Agriculture and Fisheries. 1991. Managing harvesting activities in intertidal habitats. A discussion paper. NSW Agriculture and Fisheries, Australia.	Outlines the problem caused by increasing numbers of human foragers removing ‘all forms of life’ from intertidal areas. Bag limits introduced for some species in 1988 have been ineffective in controlling harvesting activities. Some harvesting methods cause significant habitat damage. Describes proposed management plan to totally protect selected sites from harvesting activities, which should

	then serve as a reservoir for repopulation elsewhere. Also tightly controls harvesting elsewhere by specifying permitted methods and imposing bag limits on many intertidal invertebrates. Proposes to develop an educational programme, improve effectiveness of enforcement, and monitor effectiveness.
Newell, G.E. 1948. A contribution to our knowledge of the life history of *Arenicola marina* L. *J.Mar.Biol.Ass.UK*. 27:554-580.	Not reviewed.
Newell, G.E. 1949. The later larval life of *Arenicola marina* L. *J.Mar.Biol.Ass.UK.* 28: 635-639.	Not reviewed.
Nicholson, D. 1979. Observations on the population structure and recruitment of the lugworm *Arenicola marina*, with particular reference to its exploitation as a bait species. Unpublished. Department of Zoology, University of Newcastle-upon-Tyne.	Not reviewed.
Norris, K., Bannister, R.C.A., and Walker, P.W. 1998. Changes in the number of oystercatchers *Haematopus ostralegus* wintering in the Burry Inlet in relation to the biomass of cockles *Cerastoderma edule* and its commercial exploitation. *Journal of Applied Ecology*. 35: 75-85.	Quoted in Quigley and Frid 1998. Not reviewed.
Olive, P. 1984. Survey of the littoral infauna at Newton-on-Sea. Report to the Nature Conservancy Council. CST Report no. 533.	Describes unique scientific importance of the beach, which has a diverse fauna including several species that only occur at this locality in Northumberland and Durham. The same area has a population of large lugworms. Exploitation of these stocks would result in predation and accidental damage to the sediment structure and other associated species, including *Echinocardium cordatum*, and the unique interstitial fauna of the beach. Recommends that present policy restricting bait digging should continue.
Olive, P.J.W. 1985a. A Study of lugworm populations in the Lindisfarne National Nature Reserve. Final report to the Nature Conservancy Council. CST Report 569.	Mainly summarised in Olive 1993. Describes two-year period when no bait digging took place in Budle Bay, followed by 6-month period of restricted bait digging. Study demonstrated that the site could not withstand the level of exploitation experienced in winter 1984/85.
Olive, P.J.W. 1985b. Slow grow white ragworm. *The Sea Angling Handbook.* Winter 85/86. 28-31.	Popular article. Describes biology, age, and breeding strategy of *Nephtys.* These species are long-lived, slow-growing and offspring have a low survival rate to adulthood. Additionally, they do not breed every year. From 1975-1985 one of the common British species only bred successfully in two years. Also describes the much larger more ferocious US bloodworms *Glycera*, which inject their prey with poison.
Olive, P.J.W. 1985c. Ragtime. Article in: *The Sea Angling Handbook*. Autumn 1985. 21-23.	Popular article. Describes biology and breeding cycle of *Nereis* species. Explains that bait beds are inadequate to meet demand, as a result of over-digging, pollution and land claim in estuaries.
Olive, P.J.W. 1986. Lugworm; abuse or management?. Article in: *The Sea Angling Handbook.* Autumn 1986. 61-63.	Makes suggestions for rotational closure of bait beds to increase yields.
Olive, P.J.W. 1987. Menai Strait ragworm studies. A report to the Nature Conservancy Council. CSD Report No. 802.	Describes unusual nature of king ragworm population in the Menai Strait. Despite rapid initial growth of young worms in the Strait, comparable to that achieved in the laboratory, there is an unusually long period of growth in most individuals before spawning occurs. Animals of two to three feet in length that show no signs of maturation have been recorded. Small individuals are very scarce. The maximum proportion of the population found to be spawning in one year was about 20%, much lower than normal. The study site was subject to intensive digging, resulting in serious and at least semi-permanent environmental damage from boulder displacement and exposure of underlying boulder clay. This would result in serious damage to the associated and important faunal communities present at these sites.
Olive, P.J.W. 199? Polychaeta as a world resource: patterns of exploitation, management and the potential for aquaculture based production. *Memoires Museum d'Histoire Naturel, Paris.* ????	Not obtained.

Olive, P.J.W. 1993. Management of the exploitation of the lugworm *Arenicola marina* and the ragworm *Nereis virens* (Polychaeta) in conservation areas. *Aquatic Conservation* 3, 1-24.	Presents two case studies: *Arenicola marina* exploitation in the Lindisfarne National Nature Reserve, and *Nereis virens* in the Menai Strait. Neither are examples of a sustainable economic pattern, and could not support continuous production or export to significant markets. Management of the exploitation of bait populations in conservation areas is discussed in relation to world patterns of utilisation and supply.
Olive, P.J.W. and Cadman, P.S. 1990. Mass mortalities of the lugworm on the South Wales Coast: a consequence of algal bloom? *Marine Pollution Bulletin* 21(11):542-545.	An algal bloom on the South Wales coast first affected the Burry Inlet in September 1990, and four weeks later Swansea Bay. This is thought to have led to a decline in the lugworm population.

Olive, P.J.W. and Cowin, P.D.B. 1994. The management of natural stocks and the commercial culture of polychaeta as solutions to the problems of bait digging and worm supply for sea angling in the UK. *Polychaete Research* 16: 23-27.	Not obtained.
Poitier, A. de (date?) Bait digging in Chichester Harbour. Internal report to Chichester Harbour Conservancy.	Not obtained.
Povey, A. and Keough, M.J. 1991. Effects of trampling on plant and animal populations on rocky shores. *Oikos* 61: 355-368.	Quoted in Quigley and Frid 1998. Not reviewed.
Quigley, M.P. and Frid, C.L.J. 1998. Draft management report: The ecological impacts of the collection of animals from rocky intertidal reefs (pp. 42). A report to English Nature from the Dove Marine Laboratory, Cullercoats, North Shields, Tyne and Wear, NE30 4PZ. Supported by the European 'LIFE' Programme.	Reviews nature and scale of collecting activities upon rocky intertidal reefs within the Berwickshire and North Northumberland cSAC. Sets out options for management and recommendations to address issues identified. Target organisms were *Carcinus maenus*, *Cancer pagurus* and *Littorina littorea*. Main recommendations were for monitoring the activity and establishing a zonation scheme with no-take zones in representative pristine sites throughout the SAC to act as a source of recruits.
Rees, H.L. and Eleftheriou A. 1989. North Sea benthos: A review of field investigations into the biological effects of man's activities. *J.Cons.int.Expl.Mer.* 54(3): 284-305.	Reviews several of the papers listed here in assessing effects of anthropogenic activity on the benthos. Notes increase in bio-availability of lead and cadmium (Howell 1985), and species and community effects reported by several authors.
Robson, E.M. and Williams, I.C. 1971. Relationships of some species of Digenea with the marine prosobranch *Littorina littorea* (L.). II. The effect of larval Digenea on the reproductive biology of *L.littorea*. *J. Helminthology*. 45, 145-149.	Winkles are rarely affected by parasitic trematodes prior to first spawning. As they grew older, rate of infection grew exponentially. Trematode infections so reduce egg production by affected females that in some populations the entire egg production comes from first-time spawners.
Roch, P., Giangrande, A., & Canicatti, C. 1990. Comparison of hemolytic activity in eight species of polychaetes. *Marine Biology*. 1990. vol. 107, no. 2, pp. 199-203.	Included in this review because they mention a purchase from a retail shop in Italy of a *Nereis* sp. imported from the Yellow Sea, Japan.
Scott, F.E. 1989. Human disturbance of wading birds on the Ythan Estuary. Unpub. BSc thesis, Department of Zoology, University of Aberdeen.	Considers limited disturbance by bait diggers to have relatively little effect on feeding waders.
Shackley, S.E., Coates, P.J., and Giesbrecht, G.E. 1995. Cockles and Bait Digging in the Burry Inlet. Burry Inlet and Loughor Estuary Symposium: State of the estuary report, Part 2; Supplementary Proceedings to the Burry Inlet Symposium 1995.	An experimental investigation into the effects of bait digging on cockles. Substratum turned over and broken up to a depth of about 30 cm. Compared effects of backfilling and digging trenches with spoil heaps. Both methods caused over 90% cockle mortality (probably through burial) within 6 days. Differences between controls and dug plots still detectable after 3 months. Older cockles more susceptible to effects of digging. Backfilling less damaging because a smaller surface area affected than by using trench and spoil heap method.
Shahid, M.H.S. 1982. The reproductive biology, population genetics and population dynamics of the lugworm *Arenicola marina* in relation to bait digging on the Northumberland coast. PhD Thesis. University of Newcastle upon Tyne.	Most lugworms breed between October and March, usually in November and December, although up to 20% of the population may spawn in July to September. Each animal spawns on a single day, with the entire population of a beach completing spawning within just a few days. Populations on different beaches breed at different times.
Sharpe, A.K., and Keough, M.J. 1998. An investigation of the indirect effects of intertidal shellfish collection. *Journal of Experimental Marine Biology and Ecology*. 223:19-38.	Quoted in Quigley and Frid 1998. Not reviewed.

Sherman, K.M. & Coull, B.C. 1980. The response of meiofauna to sediment disturbance. *Journal of Experimental Marine Biology and Ecology*, 46, 59-71.	Not reviewed.
Siegfreid, W.R. (ed.) 1994. Rocky shores – exploitation in Chile and South Africa. *Ecological Studies* Vol. 103. 177pp. Springer-Verlag.	
Simpson, J. 1992. Preliminary research into bait digging in Pagham Harbour. No publication details.	Aimed to ascertain bait digging pressures, location and distribution of the main beds and to establish suitable long-term survey techniques prior to a five year investigation into ecological implications (West Sussex).
Smit, C.J. and Visser, G.J.M 1993. Effects of disturbance on shorebirds: a summary of existing knowledge from the Dutch Wadden Sea and Delta Area. *Wader Study Group Bulletin*. 68: 6-19.	Quoted in Quigley and Frid 1998. Not reviewed.
Stour and Orwell estuaries group. (date?) Stour and Orwell estuaries management plan.	Lists concerns about bait digging. Policy LR4 states: Promote understanding and the necessary control to provide a sustainable level of bait digging.
Suffolk Coasts and Heaths Project. (date?) Stour and Orwell estuaries management plan issues.	Identifies issues resulting from bait digging.
Tamar Estuaries Bait Collection Working Group. 1998.	The Working Group was set up when bait collection (particularly the level and impact of crab trapping and worm digging and the abuse of access and property rights) was identified as an issue of concern by the Tamar Estuaries Management Plan Consultative Document. The Group is comprised of recreational and commercial collectors and recreational marine fishery bodies. It notes that there are some 20,000 crab traps in the Tamar Estuaries, of which some 8,000 are commercially used. Commercial traps yield some 90,000 crabs, recreational anglers collect some 20,000. Approximately 70% of the commercial yield is sold to other parts of the UK. Most worm digging is carried out by recreational anglers. The Group recommends a voluntary management approach involving all key players, in harmony with the Tamar Estuaries Management Plan. Improved public awareness, production of a local bait collectors' code and an educational programme, surveys, monitoring and zoning of activity are all recommended.
Townshend, D.J. and O'Connor, D.A. 1993. Some effects of disturbance to waterfowl from bait digging and wildfowling at Lindisfarne National Nature Reserve, north-east England. In: Davidson, N. and Rothwell, P. Disturbance to waterfowl on estuaries. Wader Study Group Bulletin, 68:47-52.	Bait digging activity greatly reduced the extent of use of the area by several waterfowl species, apparently through the direct effects of disturbance. Large numbers of people were spread across the tidal flats disturbing waterfowl attempting to use the wildlife refuge. Average peak winter numbers of wigeon and two of the main wader species (bar-tailed godwit and redshank) before and after restrictions on bait digging showed that in years when bait digging took place on all or parts of the Bay the numbers were substantially lower than in years when there was no bait digging. The difference was most marked for wigeon. These differences were not considered to be due to between-year differences in the local populations, as it was a larger proportion of the Lindisfarne population which used the Bay, implying that it may be a preferred area for these species and that birds which would otherwise have fed there were prevented from doing so by the presence of bait diggers. Substantial increases in the populations of four other species of wildfowl using Budle Bay were also recorded in the year following prohibition of bait digging (inc. 119% for shelduck, 700% for wigeon).

Underwood, A.J. 1993. Exploitation of species on the rocky coast of New South Wales (Australia) and options for its management. *Ocean and Coastal Management* 20, 41-62.	Summarised the widespread, continuous and destructive patterns of human harvesting of intertidal and subtidal invertebrates and algae, the nature and types of catches, and the intensity of the activity on the rocky coast of New South Wales. Direct effects include the loss of individuals removed from breeding populations. Indirect effects include loss of prey items for other species, and loss of habitat. Management options, including general or selective bag limits, bans on harvesting for food and bait on the whole coast or in selected areas, are reviewed. Complete and enforced closure of certain areas is considered to be the only realistic option. Criteria for selection and needs for public education and monitoring to determine effectiveness are briefly discussed.
Wash management strategy discussion papers. September 1990.	Papers on public access, recreation and bait digging.
Wege, D.C. 1987. The effect of boulder turning by bait collectors on intertidal boulder fauna. University College of Wales, Swansea. Report to the Nature Conservancy Council. CSD Report.	Results published in Liddiard *et al.* 1989.

Appendix IV. Legal considerations

The following general legal interpretations are provided by way of context to the more specific legal framework set out in Section 4. The exact legal interpretations are different across the country and the reader is recommended to seek expert legal advice in connection with a bait collecting issue.

A.IV.1 Definition of the shore and intertidal area covered by byelaws

Attorney-General v. Chambers (1854) 4 De Gex MEG 206) proposed the seashore as "that portion only of land adjacent to the sea which is alternatively covered and left dry by the ordinary flux and reflux of the tides". In England and Wales, this has, until recently, been understood as including the area delimited by the mean high water mark and mean low water mark (unless extended by historic charter or local legislation); in other words the average high and low points of the 'ordinary' tides that occur between the extremes of spring and neap tides. However, recent case law has used a more meaningful definition of the 'ordinary' rise and fall of tides at any given part of the tidal cycle.

Tides are caused mainly by the gravitational attraction between the earth and the moon. Because the timing of tidal rise and fall follows the timing of a lunar day (24.8 hours), the period between high and low water is slightly over 12 hours, and the tidal cycle takes place a little later each day. Spring tides occur when the sun, moon and earth are all in conjunction, resulting in a stronger gravitational force acting on the sea. This produces tides that rise very high and fall very low on the shore, particularly during the spring and autumn equinoxes when the sun is closest to the equator - but such tidal movements are still 'ordinary' - they occur in a predictable fashion each year. Neap tides occur a week after springs, when the gravitational force is less, and the difference in height between the high water mark and the low water mark is much smaller than during springs. Spring tides and neap tides therefore both occur twice every lunar month, and the largest springs and smallest neap tides always occur at the same time of day and night every two weeks.

The upper limit of the foreshore is clearly defined in Halsbury's Laws (4th edition) Vol. 8, paragraph 1418, which describes the foreshore as "land between high and low water mark, the right being limited landwards to the medium line of the high tide between spring and neap tides". This landward limit to the shore (also referred to as the foreshore or seashore) is commonly referred to as the Mean High Water Mark.

In the Court of Appeal judgement over Anderson v. Alnwick District Council (CO/1705/91), the Judges accepted the common law rule that the definition of the High Water Mark as the upper limit of the shore should remain, 'for practical reasons', at the line of 'medium tides'.

The lower limit of the shore is not as clear in legal terms, and has been applied in a different way in Scotland than in England and Wales. In Scotland, the lower limit of the foreshore, its ownership, and the extent of planning legislation over the shore, has usually been defined as the mean low water mark of Spring Tides. It is therefore only during periods of extreme low water spring tides, or low water combined with unusual meteorological conditions (high barometric pressure and offshore winds), that areas will be uncovered by the sea that are not legally part of the foreshore. In England and Wales, however, the seaward extent of jurisdiction of local planning law on the foreshore has until recently been defined as the low water mark of ordinary tides (or Mean Low Water Mark), where ordinary tides are those that occur between springs and neaps. This means that, during the low water of spring tides, areas of shore will regularly be exposed that are not legally defined as 'foreshore'.

This definition has caused difficulty with regard to the enforcement of byelaws controlling activities on the lowest levels of the foreshore. It is virtually impossible to define the low water mark of ‘ordinary’ tides on the shore during periods of low water spring tides, when the sea has receded further than this invisible line. However, recent case law seems to have clarified the situation.

Briefly, baitdiggers had claimed in Anderson v. Alnwick District Council (CO/1705/91) that a local authority byelaw prohibiting baitdigging in part of Boulmer Haven only extended to the Mean Low Water Mark. Digging on the shore exposed during low water spring tides could therefore be undertaken without infringing the byelaw. This case went to appeal, and resulted in a judgement by the Court of Appeal (1992 - 1 WLR 1156) that the local authority byelaws extend to the fluctuating low water line as it is at any time, not just at mean low water. The judgement stated: “...the text of the byelaw is correctly interpreted as meaning the area of the seashore from time to time, and the low water line means the seawards boundary of that area, in other words, the low water mark from time to time.”

In summary, following the judgement given in recent case law (Anderson v. Alnwick District Council), planning legislation and other byelaw making powers applying over the foreshore now cover the entire intertidal area which is exposed from time to time by the sea. It is likely that the same position may be argued to exist in Scotland and Northern Ireland, although additional case law may be required to clarify this – the judgement in Adair v. the National Trust over bait collection in Strangford Lough, Northern Ireland, did not discuss this point.

A.IV.2 Ownership of the foreshore

Under Roman law, the shore of the sea, as far as the waves go at their furthest point, is considered as belonging to all men. However, today, most of the foreshore in the UK (including at least 50% of the Scottish foreshore) is owned by the Crown, and managed by the Crown Estate Commissioners. Some areas of foreshore are owned by local planning authorities, harbour authorities, private estates or landowners. Their claim of ownership may extend to the seabed (below the low water mark), particularly within sea inlets, but this subtidal extension of private ownership is often disputed by the Crown Estate Commissioners. The ownership of some areas of foreshore (at least in Scotland) is currently in dispute.

The ‘natural products’ found on the seashore belong to the owner of the shore, but not ‘seafish’. In addition, some landowners have ancient proprietary rights over ‘seafish’ associated with their ownership of coastal land, for example over adjacent shellfisheries. Their fishing rights may not be removed by byelaw without the consent of the interested parties (Huggett 1995b).

Of course, landowners may permit a person to take intertidal ‘products’ or issue licences for them to do so, if they are not already permitted to take these products as part of a public right. The circumstances under which landowners may take these actions are outlined in more detail below.

Regardless of the details of private, local authority or Crown Estate ownership of the foreshore, members of the public are also entitled to exercise certain rights over this area. These rights may be separated into the following main categories: common law rights, customary rights (including profits à prendre), and tolerances. The latter two only apply in those cases where common law rights do not exist. Regulating the exercise of such public activities is often extremely difficult to address, because it is difficult to identify those members of the public exercising the same, or to control fully those activities carried out under common law right without the introduction of new primary legislation.

A.IV.3 Common law rights over the foreshore

The Judgement of Girvan J in Adair v. The National Trust (1997) points out that: "The common law ... has not always developed on the basis of logic and the common law, in particular in the context of determining the rights of the public on the foreshore, has developed piecemeal and not as a reasoned whole." The following relevant Case Law is quoted:

Brinkman v. Matley [1904] 2 Ch 313 at 315, Buckley J: "By the common law all the King's subjects have in general a right of passage over the sea with vessels for the purposes of navigation and have prima facie a common of fishery there and they have the same rights over the foreshore at the times when the foreshore is covered with water."

Attorney General for British Columbia v. Attorney General for Canada [1914] AC 153, Viscount Haldane LC: "...the subjects of the Crown are entitled as of right not only to navigate but to fish in the high seas and tidal waters alike. The legal character of this right is not easy to define. It is probably a right enjoyed so far as the high seas are concerned by common practice from time immemorial, and was probably in very early times extended by the subject without challenge to the foreshore and tidal waters which were continuous with the sea, if, indeed, it did not first take rise in them. The right into which this practice is crystallised resembles in some respects the right to navigate the seas or the right to use a navigable river as a highway, and its origin is not more obscure than these rights of navigation. Finding its subjects exercising this right immemorial antiquity the Crown as parens patriae no doubt regarded itself bound to protect the subject in exercising it, and the origin and extent of that right as legally cognizable are probably attributable to that protection, a protection which gradually came to be recognised as establishing a legal right enforceable in the Courts."

Buckley J's judgement in Brinkman v. Matley [1904] 2 Ch 313 at 315 states "When the sea recedes and the foreshore becomes dry there is not, as I understand the law, any general common law right in the public to pass over the foreshore. There are certain limited rights". For example, the Courts have held that there is no right to cross the foreshore to exercise their right to swim or bathe in the sea (Blundell v. Catterall (1821) 5 B&Ald 268, and Brinkman v. Matley [1904] 2 Ch 313), or to hold meetings or deliver sermons (Llandudno Urban District Council v. Woods [1899] 2 Ch 705) or to place chairs on it (Ramsgate Corporation v. Debling (1906) 70 JP 318) or to go there to gather seaweed, even though there is a public right to take seaweed floating in the sea (Hove v. Stowell (1833) Al & Nap 348 (IR)). The above activities are considered to be tolerances in the UK (see below - although some of these activities are recognised as a right in certain of the United States).

At common law, there is undoubtedly a public right to take fish from the tidal waters around the Kingdom. This common law right extends from the outer limits of territorial waters of the sea to all inlets and the tidal reaches of all rivers and estuaries, Adair v. National Trust (1997 judgement of Girvan J) reviews the complicated nature of the limited public rights over the foreshore (referred to in Brinkman v. Matley, see above), and how the public right to fish in tidal waters is usually extended to include the collection of fish including shellfish on the exposed foreshore when the tide is out. Girvan quotes the following sources:

Hall's "Essay on the Rights of the Crown and the Privileges of the Subject in the Seashores of the Realm" (2nd Edition, 1875) states: "As the public right of fishery cannot be enjoyed without making use of the seashore for egress and regress or for other essential conveniences which the fishery requires in order to be carried on with effect, the use of the seashore, for all purposes essential to the enjoyment of the right of fishery necessarily accompanies such right. ... The catching of shellfish on the seashore ... would seem to constitute an integral part of the public right ... The fishery for lobster, crab, prawns, shrimps, oysters and various other shellfish ... is carried out in every fishing village on the coast and is one very useful and valuable branch of the fishing trade. The catch of these fish is, therefore, part of the public (right)."

Bagott v. Orr 2 B&D 472 states: “Prima facie every subject has a right to take fish found upon the seashore between high and low water mark but such a general right may be abridged by the existence of an exclusive right to some individual. Quaere: if there is a prima facie right in the subject to take fish shells found on the seashore between high and low water mark.” As pointed out by Evans LJ when giving judgement over Anderson v. Alnwick DC [1993] 3 All ER 613 at 621, it is not clear whether the ruling was made in order to allow the claim in respect of shellfish to proceed, rather than a final ruling that it was correct in law. However, in Donnelly v. Vroom [1908] NSR at 327 the Nova Scotian Court of Appeal considered that Bagott v. Orr was “a clear recognition of the common law right ... to take and carry away shellfish upon and from the land ... between the high and low water mark.”

Legal advice to the former Nature Conservancy Council (quoted in Fowler 1992, from correspondence in NCC files) had counselled that “it is well established in law that the public right to fish (in the sea) does not include any right of interference with the soil (the land under the sea)”. Had this advice been upheld, it would have meant that there is no such ancillary right to dig bait (at least in England and Wales) and that baitdigging was a 'tolerance'. However, the Judges in Anderson v. Alnwick DC agreed that this public right to gather bait is a right ancillary to the public right to fish. They stated: “The public right to take fish from the sea and tidal waters was jealously guarded from Magna Carta onwards. To restrict the use of worms as bait, which themselves were only to be found in the sand of the foreshore and therefore beneath the surface of the water when the foreshore was covered by the tide, would itself have been a restriction on the right. We hold therefore that a public right to take worms from the foreshore is recognised by the common law and may be properly be described as ancillary to the public right to fish. ... But it does not follow that the right is unrestricted or that it may be exercised by any member of the public at any time or place ... This means that in our judgement, that the taking of worms must be directly related to an actual or intended exercise of the public right to fish. Taking for commercial purposes such as sale clearly is not justified in this way.”

With regard to the collection of shellfish from the foreshore, in Adair v. The National Trust (1997) Girvan concluded that there is a common law right vested in members of the public to take shellfish from the shore, and that this is an incident of the public right to fish. (It is well established that fishery legislation may not discriminate between individuals who fish - whether commercial fishermen or recreational fishermen, their rights are identical in law.) Girvan’s conclusion was partly based on the consideration that the common law right to collect shellfish from tidal waters permitted the removal of shellfish during periods of high water from areas that would become foreshore later in the tidal cycle, and that it was not logical to exclude collection from the same areas when the tide went out.

In summary, recent case law confirms that there is an ancillary right to take bait from the foreshore, whether by hand collection from rocky shores or the surface of sediment shores, or by digging in sediment shores. This right must exist in order to exercise the common right to fish. However this ancillary right is restricted to the collection of bait for the actual or intended collector’s own use when fishing, and does not permit commercial baitdigging for resale. The common right to fish also includes the removal of shellfish from the shore, whether for personal consumption or commercial sale, unless this is i) an ancient proprietary right of the landowner, ii) abridged by several or regulating order, or iii) regulated by other byelaw. There are a number of byelaws that may be used to regulate the collection of bait or of ‘seafish’, but with the exception of several or regulating orders, none of these may be implemented in a discriminatory manner - they must apply equally to all individuals. This makes restricting the numbers of individuals engaged in any fishery or collection activity extremely difficult, if not impossible.

A.IV.4 Customary rights and tolerances

In the context of this review, this section really only applies to commercial bait digging. The 'natural products' found on the seashore belong to the owner of the shore. The only right which may exist to take these products from someone else's land (other than under a common law right), is a 'profit à prendre'. This right is generally attached to the holding of land (usually close to the commons where the right is practised, in this case, the shore) and is passed to each successive owner of the land. All commons are profits à prendre, but the latter may also exist in gross; not attached to ownership of land, but as a grant or prescription entitling the possessor (an individual and his heirs in perpetuity) to some use of the land. In neither case can profits à prendre be part of a public right of fishing. There are only a very few known examples where commercial bait diggers or other collectors of intertidal species carry out their activity in relation to a land holding or through inheritance.

Individuals may hold private rights to take intertidal species from a specific area of the shore. The only examples of common land units on the shore that were identified by Fowler (1992) were on the North Norfolk coast, from Holme to Burnham Overy, which include intertidal areas. Rights holders (there may be up to 150 of them) reportedly have exclusive rights to baitdigging (including commercial baitdigging) within these land units. Such private rights may arise as above by grant from a landowner or by local custom, following long use of the area. Customary rights, however, are scarce and difficult to prove in law.

Courts may accept evidence of a sufficiently long period of use 'as of right' (i.e. openly, but not by force or permission) as being equivalent to there having been a 'lost modern grant' for an individual to take bait from an area. The period of time required for such a right to have been established may be decades to hundreds of years. Such claims may be difficult to prove even for a defined group of the local inhabitants of an area. Under the Prescriptions Act (1832), which does not apply to profits à prendre in gross, it is necessary to show that the activity has taken place "as of right" for 30 years. If the activity has been exercised for 60 years it shall be deemed absolute and indefeasible, unless it appears that it was enjoyed by consent or agreement in writing.

Goodman v. Saltash Corporation (1882) App Cas Vol. 7, p. 633 deals with customary rights, in this case the profits à prendre through a grant assigned to a group of individuals in the area. This case law was one of the arguments used in Adair v. The National Trust to put forward the plaintiff’s claim to a customary right to take shellfish and to dig bait commercially from the shores of Strangford Lough. He argued that he had been doing so for years, and his father and grandfather before him. It was also asserted that a significant number of other persons connected with the fishing industry did so likewise. Opposing the claim, it was argued that such an unrestricted right would interfere substantially with the landowners’ proprietary interests. It was also pointed out that the claim to a customary right was unsustainable because it was uncertain who could exercise this right, and there could be no such customary right to what was really an asserted profit à prendre.

Girvan’s judgement in Adair v. The National Trust states: “A custom is a particular rule which has existed either actually or presumably from time immemorial and has obtained the force of law in a particular locality although contrary to or not consistent with the general law of the realm (see Lockwood v. Wood (1844) 6 QB 50 at 64 per Tindal CJ). A custom is in the nature of a local common law within the particular locality.” “To be valid a custom must have four essentials.

“1. It must have been in existence from legal time immemorial [fixed at 1189];

“2. It must be reasonable;

“3. It must be certain in respect of its nature and in respect of the locality; and

“4. It must have continued without interruption.”

Girvan points out that “It has been held that an alleged custom is unreasonable on the grounds that it would destroy the subject matter of the right and for this reason a 'profit à prendre' cannot ordinarily be acquired by custom (see Tilbury v. Silva [1889] 45 Ch Div 98 at 107, Lord Fitzhardinge v. Purcell [1908] 2 Ch 139, and Payne v. Ecclesiastical Commissioners (1913) 30 TLR 167).”

Girvan’s judgement ruled that shellfish collection was a common right not a customary right (see above). He failed the claim that commercial baitdigging (“the claim to be entitled to take lugworms from the foreshore without limitation and for general commercial purposes”) in the Lough was a customary right of the ‘fishing community of County Down’. This group of people was vague and uncertain, and the evidence of “a widespread enjoyment of an alleged right to take lugworms for general commercial purposes from the Lough” did not satisfy the Court.

Tolerances are activities that are widely undertaken without any public right. As already noted, crossing the foreshore to swim in the sea, using it to hold meetings, collect seaweed, or even sitting on the sand for recreational purposes, are all tolerances, and could be prohibited by a private landowner - although bait digging could not. Similarly, commercial bait digging is widely tolerated around the coast, where it does not cause any problem or conflict with other users (or perhaps simply cannot be identified as such).