immersion

A strategic framework for eco-recreation in British waters

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immersion – a strategic framework for eco-recreation in British waters

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Contents

(04) Introduction 1

(08) British waters – a cultural resource 2
(10) Water and wellbeing 2.1
(12) Wild swimming 2.2

(15) Geographical context 3
(16) Regeneration of coastal towns 3.1
(17) Coastal access 3.2
(18) Beach culture 3.3
(19) The rise and fall of the lido 3.4

(22) Environmental pressures on water habitats 4
(23) Fishery collapse 4.1
(24) Common Fisheries Policy and Marine Bill 4.2
(26) The wrath of the sea-fish 4.3

(27) Aquaculture 5
(28) Mariculture 5.1
(30) Land aquaculture 5.2

(31) Climate change and water 6

(34) Invasive non-native species 7
(36) Economic cost of non-natives 7.1
(37) Alien species 7.2
(38) Invasive Non-Native Species Framework Strategy for Great Britain 7.3

Contents

8 Towards a total immersion (41)
8.1 Aims and objectives (42)
8.2 Regenerating British lidos (43)
8.2.1 Sustainable freshwater aquaculture sites (44)
8.2.2 Freshwater invasive/unwanted migrant species repositories (46)
8.2.3 Sustainable marine aquaculture (47)
8.2.4 Preliminary identification of marine sites (50)
8.2.5 Marine invasive/unwanted migrant species repositories (53)
8.2.6 Purpose built facilities - rapid response units to areas of need (54)

9 References (57)

10 Appendices (60)
10.1 Some common fisheries that are potentially unsustainable (60)
10.2 Unsustainable fisheries (62)
10.3 Sustainable fisheries (62)
10.4 Migrating marine species (64)
10.5 Non native freshwater plants and animals in the UK (64)
10.6 Non native marine species in British waters (65)

Acknowledgments (75)

1/ Introduction

1 Introduction

Is this how people see British waters ?

"dangerous, dirty, cold"

Over the past ten years there has been an increasing recognition of the importance of the value of the British landscape to the wellbeing of the country's population, over and above its traditional economic value as farmland. The government's commitment to making the countryside open to all has been manifest in "Right to Roam" legislation, and work such as the Council for the Protection of Rural England's study on tranquillity has heightened awareness of the need to recognise both physical landscape features and their metaphysical impact. Marching alongside this rural renaissance have been, now mainstream, environmental initiatives that enhance and preserve ecologically sensitive habitats that everybody can enjoy.

However these successes now need to be extended to a forgotten part of the land, its waters and seas, which remain feared, neglected and sometimes actively despoiled by a significant majority.

In spite of the fact that 72% of the UK's population visit the coast each year a recent survey by Natural England suggests that people in our country think our waters are terrifying, polluted and unwelcoming and this attitude is mirrored in the environmental impacts. Whilst we have cleaned up our beaches, and otters are returning to some

of our rivers there are still major issues to overcome:

≈ climate change, warming waters and threatening mass extinctions
≈ overfishing, threatening fishery collapse
≈ eutrophication (oxygen enrichment of sea water due to nitrate run off from land based farming), causing species depletion
≈ invasive species imported into coastal waters, estuaries and rivers
≈ pollution from both land sources and shipping ending up as flotsam/jetsam
≈ threats to genetic diversity of wild fish stocks from mariculture.

Out of sight, out of mind. We must learn to appreciate our watercourses, streams, culverts, ponds, lakes, reservoirs, rivers, bays, estuaries, marshes and sea again if we, and the flora and fauna we share Britain with, are to survive the inevitable changes to our climate that are taking place. Just because we can't see under the rolling steel grey surface of the sea, or the rippling river's current, does not mean we don't have a major impact on what occurs there.

Immersion is a project which sets out bring art, architecture and ecology together to address some of these problems by engendering new attitudes to British waters, particularly by attempting to use the forces of leisure and recreation for the benefit of the environment.

Research with penguin, 2007

2/ British waters – a cultural resource

2 British waters – a cultural resource

The tranquil cot, the restless mill,
The lonely hamlet, calm and still,
The village spire, the busy town,
The shelving bank, the rising down,
The fisher's boat, the peasant's home,
The woodland seat, the regal dome
In quick succession rise to charm
The wind with virtuous feelings warm
Till, where the widening current glides
To mingle with the turbid tides,
Thy spacious breast displays unfurled
The ensigns of the assembled world
Throned in Augusta's port
Imperial commerce holds her court.

Thomas Love Peacock, The genius of the Thames:
A lyrical poem in two parts, 1810

It is well known that geographically it's not possible to be more than 70 miles from the sea. Ever since the North Sea swept south over the fragile land bridge, all that remained of Doggerland between what is now the British Isles and mainland Europe,the sea has played a huge part in the country's history as transport for trade, source of food and defence against invasion.

Once the channel had been crossed traders and invaders alike used Britain's river network to penetrate inland. These same rivers, lakes and water courses also provided the fresh water and food needed for settlements to flourish. It is obviously no co-incidence that all of our oldest major cities have rivers flowing through them, or are on the coast, London and the Thames, Bristol and the Avon, Glasgow and the Clyde.

Over time, as the populations of Britain's cities grew, their populations started to create their own water courses for transport and reservoirs for drinking water. The adaptation of water channels which started in the 18th century has left us with the Manchester Ship Canal, Kielder Reservoir and other great man-made features in our landscape.

"The best of men, and the noblest of minds, rejoice to see the people following the foretrod routes of pleasure." Thomas Cook, C.19th

The use of water for recreational purposes arguably developed at the same time as this great water building period and the medicinal value of bathing was "rediscovered" by the Georgians, who reinvigorated the Roman tradition of the bath house, and re-built whole towns around them, Bath, Tunbridge Wells and Buxton to name a few. These places became major social centres at the same time, providing places for geographically isolated and disparate members of society to congregate. Taking the waters therefore established places where a certain amount of social fluidity was allowed, different families and groups could mix and

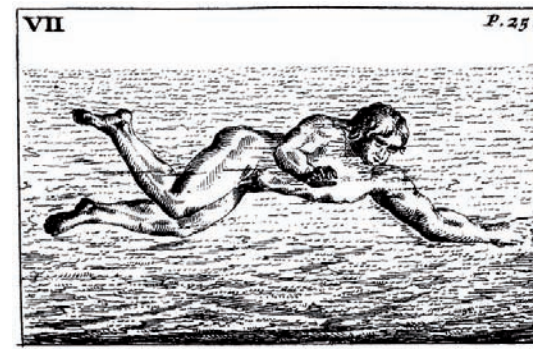


Illustration from Theodorus Bailey Myers Mason's 1879 pamphlet, *The Preservation of Life at Sea*

marriages (and affairs) could be arranged. Places set aside for healing were in fact the precursors of contemporary resorts which are now places for breaking free from "normal" social boundaries, from the genteel pleasures of early seaside resorts such as Brighton, to the establishment of more convivial working class holiday centres such as Blackpool in the 19th century.

Water and wellbeing 2.1

Glide gently, thus forever glide,
O Thames! that other bards may see,
As lovely visions by thy side
As now, fair river! come to me.
Oh glide, fair stream! for ever so;
Thy quiet soul on all bestowing,
'Till all our minds forever flow,
As thy deep waters now are flowing.

William Wordsworth, Lines written near Richmond, upon the Thames at evening, 1790

Inflatable suits from the 1950's – a cup of tea, the papers and a cigarette

At the same time as the development of spa towns in the 17th century using springs as their water source, the seaside also started to develop as a place for health, with bathing (as opposed to swimming) involving immersion to effect the cure. The seaside was also a place which more people could access, avoiding the socially superior spas. Along with increased mobility and wealth this meant that by 1911, 55% of the population of England and Wales made trips to the seaside.

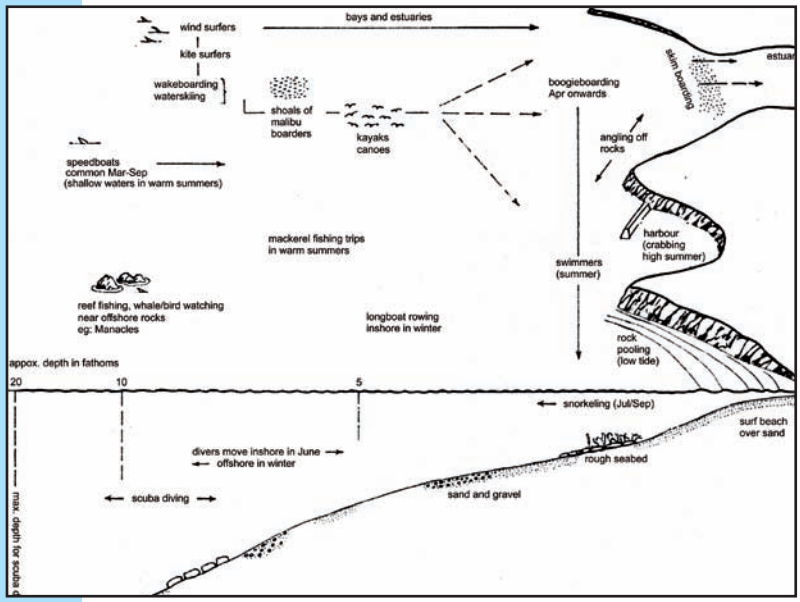
In the 21st century water and watersides are within easy reach of many

British waters – a cultural resource

Water and wellbeing

of us, and as their value for communication and transport has dwindled their primary importance is for their aesthetic and recreational value. They can provide opportunities that cut across social divides, including deprivation and race. Recent research (February 2005) by the Environment Agency indicates that nearly half the population of England and Wales enjoyed time on or near water in the previous 12 months.

"The benefits – social, cultural, educational, economic and health – of recreation are considerable. It also has a key role to play in regeneration, as the catalyst for improvements to local environments. Community recreational opportunities and facilities generate value and a sense of local ownership. There are spin-off benefits for employment and the economy in both the town and country."[2]



Map of sea and coast water recreation

Public health is an important reason for promoting water sport and activities which have a role in improving both mental and physical health. Many water sports require sustained physical activity, e.g. swimming, rowing, dinghy sailing, surfing and canoeing. This has been recognised by the Department for Culture, Media and Sport[3] which has identified swimming, canoeing, sailing and rowing as key activities for the UK. Our success in this field is manifest, with 12 of Great Britain's 30 medals in the 2004 Olympics coming from water sports such as sailing. The 2012 Olympics will further raise the profile of water sports with the sailing events being sited in Weymouth. These activities also have wider social benefits and many sports have developed social inclusion programmes, such as Canoe Paddleability, the Royal Yachting Association's On Board Scheme and 'Get Hooked on Fishing'.

Fishing is increasingly becoming a priority for those agencies concerned with the environment as a way of linking physical recreation and access to open spaces and the public health agenda, such as the Environment Agencies Angling 2015 policy which takes as its basis the UK Sustainable Development Strategy 'Securing the Future' and the work of Policy Action Team 10[4]. Fishing is also a good example of where habitats can benefit environmentally from management for recreation, with significant investment by landowners and agencies in stocking and maintaining waterways such as reservoirs and lakes.

Economically there is also evidence of the value of water recreation. For instance a report by Invest in Fish South West[5] claims that sea angling is worth £165m per annum

and creates 3,000 jobs. In Cornwall and the Isles of Scilly alone, research in 2004 identified the value of water sport related businesses, with surfing worth £64m, sailing £52m, scuba diving £17.5m and gig racing £2.5m[6].

Recent research undertaken by the Henley Centre (2005)[7] for Natural England, allied to the findings of workshops undertaken in the development of this strategic plan, suggest that there are some general trends in outdoor recreation that are relevant. These are likely to shape the future of demand for water related recreation in the region:

≈ "We live in an increasingly affluent society, with a greater focus on the 'experience economy' where people will pay for services and experiences rather than material goods

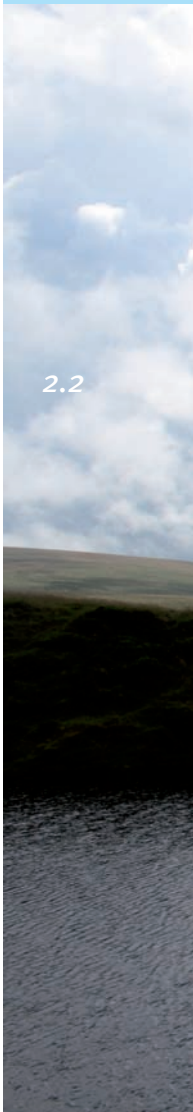
≈ There are an increasing number of older people who are developing a greater range of interests associated with health and well being, including in 'non-traditional' adventure based or challenge activities. At the same time young adults have increasingly sedentary and 'indoors' lifestyles

≈ There is an increased need for information, both in terms of extending its availability, and in providing it in a wider range of formats

≈ Warmer air and sea temperatures (brought about by climate change) allied to better service and value for money, could increase tourism demand as traditional locations – the Mediterranean for example – become too hot. Warmer seas could also encourage more interesting marine life, giving a boost to activities such as sea angling, scuba diving and boat tours."[8]

Wild swimming

2.2



And call they this Improvement? — to have changed,
My native Clyde, thy once romantic shore,
Where Nature's face is banish'd and estranged,
And Heaven reflected in thy wave no more;
Whose banks, that sweeten'd May-day's breath before,
Lie sere and leafless now in summer's beam,
With sooty exhalations cover'd o'er;
And for the daisied green-sward, down thy stream
Unsightly brick-lanes smoke, and clanking engines gleam.

Thomas Campbell, Lines on revisiting a Scottish river, 1826

2 British waters – a cultural resource

2.2 *Wild swimming*

One example of the trends identified by the Henley Centre is the development of a new wild swimming movement, lead by the River and Lake Swimming Association and the Outdoor Swimming Society.

"A century ago, Britain had hundreds of outdoor swimming clubs: The New Town Water Rats, The Tadpoles, The Serpentine, The Sheep's Green Swimmers, The High Gate Diving Club…names that now seem to shimmer in a sepia haze. Back then, it didn't seem remotely eccentric to wallow in a tidal pool, or crawl down a flashy river. But after the Second World War came the decline of lido culture, the rise of the municipal pool, the pollution of the river systems, and the understandable prizing of what we oddly call creature-comforts: air-conditioning, thermostats, the sofa… "[9]

Both organisations aim to increase public awareness of the ecological, social and health benefits of swimming outdoors. The RLSA also lobbies the government and Health and Safety executive to facilitate the activity. Their position is backed up by research which suggests that 12.35% of

Wild swimming on Dartmoor

UK's population (5.95million) participated in outdoor swimming and 12.49% (6.01million) participated in spending general leisure time at the beach. With significant rises in the numbers of people angling from the shore (+0.34%), canal boating (0.25%), outdoor swimming (1.75%) and spending general leisure time at the beach (0.99%).[10]

"Clearly, whichever way one looks at the figures, swimming outdoors is the most popular UK watersport. It is therefore extraordinary that the activity is, at best, totally ignored by Government bodies, local authorities and other public bodies."[11]

There does however appear to be evidence of changing attitudes to water recreation and now even the Environment Agency acknowledges that health and safety concerns and development pressures have resulted in fewer local fisheries, and the loss of boatyards and the infrastructure to support boating.

"This highlights a need to create new waters with access as valued public recreational amenities, comparable to playing fields and sports centres."[12]

3/ Geogprahical context

Geographical context
Regeneration of coastal towns

Since the 1960's Britain's coastal towns and resorts have harboured economic and social degradation the equal of some inner city areas. Physical isolation, the seasonality of labour, cheap accommodation out of peak periods which housed the unemployed and retired/aging populations, the outward migration of young people and poor quality of housing and second home ownership were just some of the factors which meant that contemporary resorts are some of the most deprived towns in the UK. Stimulated by the English Tourism Council's 2001 report "Sea Changes", a report by the House of Commons Communities and Local Government Committee on Coastal Towns in 2007 concluded that action should be taken at a national level to promote visiting the English seaside through a national coastal tourism strategy and that coastal towns should diversify their economies in order to address some of these issues.

This proposal has been addressed through one programme Sea Change, administered by the Commission for Architecture and the Built Environment which aims to use culture to make a difference to seaside resorts; contributing to sustainable, social and economic regeneration, backing investment plans in culture, heritage and public space, which should act as a catalyst to support regeneration of the resort, boosting confidence and pride in the local community.

It is obvious though that regeneration initiatives like this will need to be backed up by visionary and innovative schemes that make the most of existing resources, such as disused buildings. CABE and English Heritage indentify this in their report Shifting Sands[13]:

"There is room for more, for bigger, for better and for the inventive use of the large historic buildings that are to be found in many seaside resorts… towns appear to lack the confidence to use their heritage as part of their regeneration strategy. While they appreciate the contribution made by the historic environment, they can frequently falter when it comes to looking after it if there is the slightest hint of conflict with a more pressing social and economic agenda, even if the care and conservation of the historic environment might contribute to this outcome. It is evident, too, that there is room for the better promotion and celebration of the special nature of seaside towns. This

Rock pooling and swimming at the tidal pool, Trevone, Cornwall

includes their geography and heritage as well as the efforts that have been made to maintain their attraction for visitors."

3.2 *Coastal access*

Access to the coast has been recognised as a key priority by the Department of Farming and Rural Affairs (DEFRA) in its latest strategy and the Labour Party's Rural Manifesto of 2005, following on from the Countryside Rights of Way Act of 2000. Natural England's response to consultation recommends that initiatives be introduced that create:

≈ Secure access along the length of the English coastline, accepting that this may be subject to some exceptions, whilst considering erosion, accretion and realignment.

≈ A more accessible coastline, by creating physical routes to access the coast and by encouraging more people to enjoy the coast.

≈ Improvements for coastal wildlife and the landscape, as well as encouraging people to enjoy and understand this environment.

"The South West Coast Path is one of the region's greatest assets as far as attracting visitors is concerned. It is up there with the Eden Project, the Roman Baths and Stonehenge and when the Foot & Mouth crisis closed it, the whole of the tourism industry felt the effects." Malcolm Bell, Chief Executive South West Tourism[14]

Taking the South West as an example it has been clearly demonstrated how good quality continuous coastal access can have a positive impact on the local economy. The South West Coast Path has now been recognised as a regional icon in the South West Regional Economic Strategy 2006-2015 as a result of the Economic Value of the South West Coast Path Report 2003. South West Tourism and Tourism Associates (University of Exeter) estimated that 28 per cent of all staying visits situated within one mile of the coast were due to the existence of the South West Coast Path which accounted for £143 million total spend i.e. all spend associated with that visit.

Satellite view of Cornish coast showing littoral activity in high summer (image © Google)

"The significance of beach recreation/ tourism and its impact on coastal economy and employment is recognized and the report sheds light on the value of sport and active recreation at a local level. Support should be extended for sustainable and responsible development that supports the local economy and enhances access to the coast."[15]

Porthcothan, Cornwall

The coast then is clearly a big cultural factor for inhabitants of the UK. In 2005, the National Trust commissioned a survey exploring coastal values. The results point to the coast's continuing appeal as a place adding to the quality of people's lives.

"65% of those questioned regard visiting the seaside or coast as important to their quality of life (30% regard it as important; a further 35% consider it fairly important).Over a 12 month period, 62% of those questioned had been on a day trip and 50% on holiday to the coast or seaside. 65% felt the coast mattered to them for fresh air and exercise, 43% for peace and freedom. 59% have kept something at home that they found on a beach; 49% considered their happiest childhood memory as being by the sea; 16% want to have their ashes scattered at sea or on a beach and 7% have proposed

on the beach or coastline. 34% often day-dream about being by the sea when going about their everyday life."[16]

This is backed up by studies that have concluded that being by the seaside has tangible positive health outcomes.

"What effect does visiting the beach have on health and happiness? Very positive! 95% of respondents stated that their health and happiness was affected positively by a visit to the beach. Benefits are immediate. For example, 16% of off peak visitors felt the benefits of being with friends and family at the beach lasted up to a week after their visit compared, to 8% of peak visitors. Benefits include feeling relaxed / calmer, happier, less stressed / healthier having exercised, healthier after being outside, better after being with family and friends."[17]

Overall attitudes and perceptions are summarised in a report commissioned by Natural England, Improving coastal access: Our advice to Government (2007) which concluded that the coast was valued for:

≈ What it symbolises: many people talked spontaneously about the impact of Britain's island geography on national identity. This is most keenly felt by local coastal residents and regular visitors.

≈ Relaxation: the coast is seen as a place of rest and relaxation, particularly among those who lead busy lives, or are seeking peace and quiet.

≈ Sense of freedom: coastal visits to beaches or open areas by the coast are often associated with the word "freedom". In many cases, this feeling is one of the major reasons for visiting the coast in the first place.

≈ Scenery: coastal scenery is also important, and a recurring theme was the need to have visual access to the sea.

≈ Wildlife: people, particularly with children in mind, are drawn to the coast to experience its wildlife.

≈ Tourism: for many living close to the coast, the coast is fundamental for their livelihoods and the local economy, as well as their own pleasure.[18]

3.4 *The rise and fall of the lido*

From the 19th century onwards the medicinal value of ingesting and bathing in waters fell out of favour and in its place came a more general set of benefits to health from bathing as exercise, swimming and exposure to the sun and air for an increasingly urban population. One of the first open air pools (or in this case lakes) was the Serpentine lake in Hyde Park, London, built at the instructions of George II, to provide a safer alternative to swimming in the Thames.

Harry Riley's 1950's poster (illustrated in Liquid Assets by Janet Smith)

"To remain stationary in these times of change, when all the world is on the move, would be a crime. Hurrah for the Trip – the cheap, cheap Trip"
Thomas Cook in 1854 [1]

Open air swimming pools, or lidos as they became known from the 1930's (named after fashionable European beach resorts), became the mark of a modern town, *"emblems of municipal modernity and of faith in a brighter, more enlightened future, in much the same way that libraries had become a generation or two earlier"*[19]. In particular during the interwar years lidos came into their own with most of the ones we are familiar with today being built from the 1930's onwards. Hedonism met health as mass exercise programmes, illuminations and cutting edge architecture combined to create half gym, half playground for a population starved of entertainment and pleasure during the periods of austerity and tragedy during both world wars.

Yet almost as soon as the great age of lido building was over they became a threatened asset as, from the 1960's onwards, technology gave us indoor pools, the era of mass tourism loomed and cheap travel abroad contrasted favourably with the unpredictable British climate. A tan was a status symbol that could rarely be achieved in the lidos of Margate, Skegness or even Plymouth. Certainly the Health and Safety at Work Act and the development of a litigious society has not helped.

So whilst some lidos are still open and there have been notable restorations like Tinside Lido in Plymouth and Saltdean in Brighton, many more have closed although are potentially reopenable. Oliver Merrington's site, www.lidos.org.uk lists the following (with some original opening dates):

1. Abergavenny Lido, Wales 1938
2. Banbury Open Air Pool 1939
3. Bath: Cleveland Pleasure Baths 1817
4. Bristol, Clifton Victoria Baths 1850
5. Carterton Swimming Pool, Oxfordshire, 1970s
6. Clacton: Pier Lido 1932

Geographical context

The rise and fall of the lido

7. Grange-over-Sands Lido, Cumbria
8. Hendy Outdoor Swimming Pool, near Swansea, Wales
9. Hunstanton Lido
10. Ipswich: Broomhill Swimming Pool 1938
11. London: Eltham Park Lido 1924
12. London: Uxbridge Lido 1935
13. London: Wealdstone Open Air Swimming Bath Harrow, 1934
14. Malmesbury Outdoor Pool, Wiltshire
15. Marsden Park Open Air Pool, Lancashire, 1930s
16. Pontypridd: Ynysangharad Swimming Pool, Wales, 1920s
17. Reading: King's Meadow Swimming Baths 1903
18. Risca, Gwent, Wales
19. Ringshall: Deer Leap
20. Royston Outdoor Pool, Herts, 1930
21. Worthing: The Lido, 1897

Clearly something needs to be done…

(top) *Cleveland Pool, Bath Spa, now a fish farm (illustrated in Liquid Assets by Janet Smith)*
(above) *Eltham Park Lido (photo from www.derelictlondon.com)*

4/ Environmental pressures on water habitats

4 Environmental pressures on water habitats

Set against the need for providing access to water for a bored urban majority there remain significant concerns over the increasing pressure this brings on sea and river ecologies. According to the United Nations, around 3.6 billion people, or 60% of the world's population, live within 60km of the coast and 80% of all tourism takes place in coastal areas[20]. This becomes a major issue as, whilst in ecological terms the coast makes up only 10% of the ocean environment, it is home to over 90% of all marine species. For example, of the 13,200 known species of marine fish, almost 80% are coastal[21]. Pollution, eutrophication[22] and overfishing of wild stocks are just some of the consequences of this extensive human habitation.

"A fantastic variety of marine habitats and species exist along the UK's 20,000km coastline and within the 710,100 square kilometres of its sea and seabed, which descends to depths in excess of 2,000m over the UK continental shelf. Human activities have already had a great effect on those habitats and species and, as our seas get more and more 'busy', we are urgently seeking ways to protect biodiversity."[23]

4.1 *Fishery collapse*

Further out to sea the problems are just as great as global fishing yields decline (since 1994 this has been by 13%) and overfishing is considered to be the greatest single threat to marine wildlife and habitats, with many fish stocks in a state of serious decline.

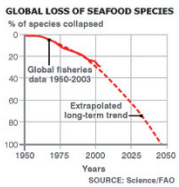
This is not a new problem and controls on fishing have been a source of debate in the UK since at least the 14th century. The following is one of the first official complaints about the use of (beam) trawling, the use of small mesh size, and of industrial fishing for animal feed:

"That such a contrivance was destructive to fish life was realised in the reign of Edward III, when in 1376-77 a petition was presented to Parliament calling for the prohibition of a 'subtlety contrived instrument called the wondyrchoum'. This consisted of a net 18 ft. long and l0 ft. wide 'of so small a mesh, no manner of fish, however small, entering within it can pass out and is compelled to remain therein and be taken ... by means of which instrument the fishermen aforesaid take so great abundance of small fish aforesaid, that they know not what to do with them, but feed and fatten the pigs with them, to the great damage of the whole commons of the kingdom, and the destruction of the fisheries in like places, for which they pray remedy'. Responsia. 'Let Commission be made by qualified persons to inquire and certify on the truth of this allegation, and thereon let right be done in the Court of Chancery'".[24]

This is a problem that has not gone away and from the industrial revolution onwards improved technology has meant that new fisheries have been opened up, fishing is undertaken in all weathers and bycatch

(the catching of species not considered edible as a by product) has increased. Many were shocked when the Newfoundland fishery for cod, which has seemed inexhaustible, collapsed in the early 1990's and still shows no sign of recovery.

"Between 1950 and 2003, 29% of fish and invertebrate fisheries within all 64 large marine ecosystems worldwide had collapsed. These regions account for 83% of the world's seafood harvest. Projecting these trends into the future, all stocks decline by at least 90% (the definition of a fishery collapse) by 2048." (25)




Stocks of cod and other Atlantic fish at the National Marine Aquarium, Plymouth

Common Fisheries Policy and Marine Bill

4.2

Politics too has had its effect and the Common Fisheries Policy (CFP) in Europe has also been blamed for underestimating fish stocks and thus leading to the sanctioned depletion of certain species. Perhaps more importantly the Policy has not been seen as legitimate by fisherman…

"…who have little sense of ownership of the process. When fishermen are compelled to follow management steps which they regard as unfounded, and which turn out to be wrong; or when they are required to act on science whose basis is incomprehensible (and also turns out to be incorrect), it is hardly surprising that the process loses authority. There is a crucial difference between being consulted, and being inside the decision making process. This is not to say that

Environmental pressures on water habitats

Common Fisheries Policy and Marine Bill

fishers have a monopoly of wisdom, but the loss of authority is a likely consequence of mechanisms that exclude legitimate interests from direct engagement."[26]

Fishing is also the subject of intense political rivalry, particularly when it is the economic mainstay of a country such as Iceland, which was involved in the Cod Wars, a confrontation with the UK in the 1950s and 1970s regarding fishing rights in the North Atlantic. Although not on the same scale similar tensions exist now amongst the nations of Europe as Spanish and Dutch fleets legitimately trawl in British waters, having purchased licences through the CFP. The political solutions to this problem are still not clear. However in its report *Choose or lose: A recovery plan for fish stocks and the UK fishing industry (2000)*, the World Wildlife Fund has recommended that there is:

≈ a commitment to investment money from the UK Treasury so that decisions are not based on short-term survival but on medium-term recovery and long-term sustainability;

≈ UK governments should commit to the delivery of regionally-based recovery programmes that involve a package of regeneration measures such as closed areas, bigger mesh sizes, scrapping vessels and lay-up schemes, along with appropriate delivery mechanisms.

WWF's Oceans Recovery Campaign (ORCA) is also calling for: a stronger network of Marine Protected Areas around the UK and integrated marine legislation in the form of an Oceans Act; a network of regeneration areas to enhance and restore fish stocks, including pilot Fishing-Free Zones.

In the UK the idea of fishing-free zones has been translated into Marine Nature Reserves, as piloted at Lundy Island in the Bristol Channel. In 1971 a proposal was made by the Lundy Field Society to establish a marine reserve around the Island, with statutory provision being included in the 1981 Wildlife and Countryside Act. The project has been very successful in re-establishing depleted marine landscape and similar provision is likely to be made under the Marine Bill currently under consideration by Parliament. Other provisions of the Bill include

≈ a strategic marine planning system directed towards more efficient, sustainable use and protection of our marine resources and creation of a series of marine plans,

≈ strengthening fisheries and environmental management arrangements so that more effective action can be taken to conserve marine ecosystems and help achieve a sustainable and profitable fisheries sector.

≈ reforming the licensing system of fishing activities, and reducing overall exploitation of freshwater fish stocks to control potentially damaging movements of live fish

There is also more consumer awareness of the issue of sustainability of wild fish stocks with campaigns aimed at encouraging the public to know which fish to avoid, and substituting these with fish from sustainably managed stocks that are caught or farmed in ways that cause minimum damage to the marine environment, for instance the Marine Conservation Societies' website www.fishonline.org [sic] – see Appendices 10.1, 10.2 and 10.3.

"there is literally not a fish that swims in our water that I cannot sell… Fish is what you might call protein without tears."(27)

Rick Stein

The wrath of the sea-fish

4.3

Together we twain on the tides abode
five nights full till the flood divided us,
churning waves and chillest weather,
darkling night, and the northern wind
ruthless rushed on us: rough was the surge.
Now the wrath of the sea-fish rose apace;
yet me 'gainst the monsters my mailed coat,
hard and hand-linked, help afforded,—
battle-sark braided my breast to ward,
garnished with gold.

Anonymous, Beowulf,
Late Anglo-Saxon epic poem

5/ Aquaculture

"They are much to be pitied
who have not been given a taste
for nature early in life."
Mansfield Park, Jane Austen

Mariculture 5.1

In 2005 marine aquaculture accounted for 47.8 (33.8%) of the 141.6 million tonnes of global fisheries production, with the remaining 93.8 million tonnes from wild capture fisheries. In 2015 the global demand for fish is predicted to rise to 172 million tonnes and aquaculture is predicted to grow to meet this demand, supplying 39%, or 67 million tonnes, of global fish requirements Scotland dominates the production of farmed marine finfish in the UK, producing nearly 130,000 tonnes of Atlantic salmon; 6,989 tonnes of Rainbow Trout and 272 tonnes of other species such as cod, charr and brown trout in 2005. The industry is subject to a number of regulations such as in relation to the siting and environmental impact of each farm.

If the marine aquaculture industry continues to grow as predicted, requirements for marine feed raw materials will not be able to be met by increasing fisheries on these industrial or feed grade fish, as many species used for fishmeal and oil are already either fully/over exploited (31% of the top 10 species used for fish feed) and/or not adequately assessed (63% of the top 10 species). Many marine species such as juvenile carnivorous fish (e.g. cod) and sea birds also depend on these fish stocks for food in their natural environment, but the implications of continuous large-scale exploitation of this food source are poorly understood. The uncertain effect of climate change on all fish stocks adds further pressure.

In addition there are concerns over escaped farmed fish which have a number of deleterious effects as they can:

- ≈ Breed with wild fish leading to genetic dilution;
- ≈ Displace eggs and destroy redds of wild salmon (in the case of escaped farmed salmon);
- ≈ Put pressure on natural resources such as food and territory through competition with wild species;
- ≈ Spread disease.[28]

The Lobster Hatchery in Padstow – part conservation programme, part visitor centre

One solution to the problems with marine aquaculture has been to look again at land based aquaculture which has a history in the UK going back to the 1st and 2nd centuries BC when fishponds were indications of status as landowners. In England, the first large-scale building of artificial fishponds was undertaken by the members of the Norman secular aristocracy to enhance their status and a large proportion of monasteries also established ponds. The best evidence for the development of commercial production dates from the later fourteenth century. Along the southern bank of the River Thames at Southwark was a series of waterfront plots known as 'The Stews'. This was formerly held to represent an area inhabited by prostitutes, but it would seem that the real origin of the name derives from the fishponds there in the 1360's, and possibly much earlier. [(29)]

"But you may contrive to keep your Stock (of fish) within Compass; for you may enlarge the Expence of your House, and gratify your family and friends that visit you, with a Dish as acceptable as any you can purchase for Money; or you may oblige your friends and Neighbours, by making Presents of them, which, from Country-man to the King, is well taken;… it is a positive Disgrace to appear covetous of them, rather more than of Venison, or any other thing; so that Presents are not only expedient, but necessary to be made by him that professeth a Mastery of fish."[(30)]

These practices are being revived by a new generation with companies such as Aquavision calling for aquaculture based on sound ecological principles, and starting an organic carp at Upper Hayne Farm, Blackborough, Devon, *"Upper Hayne Farm is the first fish farm in the UK to grow organic carp for the table. The farm entered organic conversion in 2006. The fish farm is also involved in developing, sustainable recirculation aquaculture, course fish production and a water plant nursery."*[(31)]

Carp in particular (common carp (Cyprinus carpio), Chinese carps (silver carp, bighead and grass carp, mud carp, etc.), Indian carps (rohu, catla and mrigal, etc.), barbels (such as Thai silver barb)) are well known for their contribution to low input, low cost aquaculture. World carp production from aquaculture in 1999 was 14.9 million tonnes, which was 44.7% of the world total aquaculture production in the same year. Eight of the top 10 aquaculture finfish in single species production are carps (the other two are tilapia and Atlantic salmon). In many industrialised countries, like Australia, carps are regarded as pests; in many populous counties in Asia they are the strategic species for securing rural livelihood and national food security through freshwater aquaculture. The carp species for aquaculture are generally low in the food chain in an aquatic ecosystem. Being low in the food chain is desirable in the sense that they can be grown with less costly feeds. Silver carp and bighead can be grown by fertilising the water so that the plankton for their food proliferate.[(32)]

Avon reservoir, a multipurpose aquaculture facility

6/ Climate change and water

"History judges political leaders by whether or not they respond to the great issues of their time. For today's leaders, that issue is how to move the global economy onto an environmentally sound path. We need a national political leader to step forward, an environmental Churchill, to rally the world around this mobilization."

Plan B 2.0, Lester Brown

Climate change, the increasing of global temperatures and its effects on weather systems, ecosystems and the environment generally, will inevitably affect water environments. Some scientists predict changes to the North Atlantic conveyor, a network of currents including the Gulf Stream that gives Britain its comparatively milder climate which could precipitate another ice age in the region.

Certainly it appears that the temperature of the waters off the UK coast is rising, with the Environment Agency predicting an increase in sea temperature of 2°C in the next 100 years. Inevitably this will influence the composition of life in our seas and rivers though changes in the composition and quantity of plankton, increases in the populations and ranges of southern species, decreases in populations and ranges of northern species and improved conditions for the establishment and spread of alien species from warmer areas. Other changes may include variations in sea water ph levels, a decreasing amount of freshwater in rivers (and therefore more pollution gathering in the rivers), rising waters (of Biblical proportions) and more violent weather systems. As delicately balance ecosystems even small changes to life at the base of food chains such as plankton and algae, could have enormous implications.

Following changes in food sources and habitat it is observable that new species are occurring with increasing frequency in British waters and it may be that in the future we see more Pufferfish (Pachygaster sphoeroides), Flying Gurnard (Dactylopterus volitan) and Ocean Sunfish (Mola mola) being caught off our shores. This may apply to larger species as well, as Douglas Herdson from National Marine Aquarium says:

"With shark numbers declining the way they are I do not foresee any new species of sharks turning up in British waters, apart from the odd straggler; but with changing fish populations we could [be] getting changes in relative abundance of different sharks, but

unfortunately I doubt that there will be much if any increase in their numbers; and little likelihood of our first genuine shark attack."[33]

A study of northern seas has also shown that native species are being displaced as they seek colder waters. Climate change and distribution shifts in marine fishes by Perry, Low et al[34] shows that North Sea waters have warmed by an average of 0.6°C between 1962 and 2001 and that the distributions of both exploited and nonexploited North Sea fishes have responded, with nearly two-thirds of species shifting in mean latitude or depth or both over 25 years. For species with northerly or southerly range margins in the North Sea, half have shown boundary shifts with warming, and all but one shifted northward. Species with shifting distributions have faster life cycles and smaller body sizes than nonshifting species. Further temperature rises are likely to have profound impacts on commercial fisheries through continued shifts in distribution and alterations in community interactions.

Warmer temperatures have also meant that some species have been brought to the UK for aquacultural purposes which had been thought to be unable to breed, have now started to move into our waters, Pacific Oysters imported from America are now breeding in the Helston Estuary. Whilst some may see this as positive in overall terms warmer seas are less productive than cold ones which would have a negative effect on fisheries.

Alleged sightings of Great White Sharks are a regular occurrence in Britain.

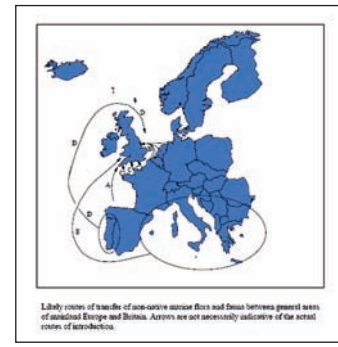
7/ Invasive non-native species

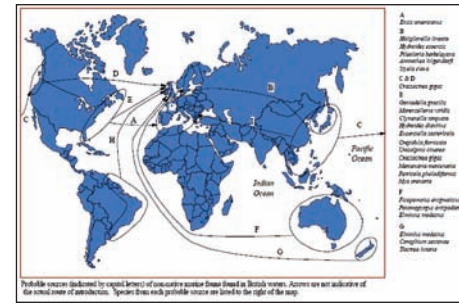
7 Invasive non-native species

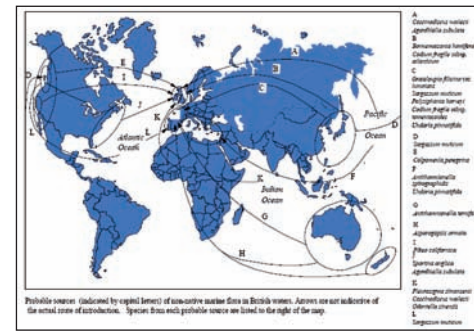
Invasive (non-native, alien or exotic) species have existed in the UK for many thousands of years, brought to this country accidentally, or for agricultural/aquacultural purposes, for example wheat or oysters . In the past their spread has been limited by natural barriers such as mountains, oceans and rivers. Also some are limited by their biology and habitat, many non-native marine invertebrates are restricted to ports and inshore waters, and their distributions on the coast of England are centered around major ports (e.g. Southampton, Thames Estuary, Plymouth). However in the era of globalisation, with the growth in trade and tourism, this situation has changed and invasive species represent a real economic and ecological threat to native species and biological diversity.

"Large expanses of water such as, in the context of Britain, the English Channel, North Sea, Irish Sea and Atlantic Ocean present barriers to many, particularly littoral, species and prevent their natural movement. Temperature and, for benthic species, the type of substratum are also considered to be barriers to the spread of species between geographic regions. These barriers can be bridged through the variety of methods which involve the intervention of man."[(35)]

The problem is not limited to UK waters and "biosecurity" is becoming a major issue around the world and the subject of international and European agreements. The Convention on Biological Diversity (CBD) states that contracting parties shall "prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species" and the EC Water Framework Directive (2000) requires that all water bodies should achieve "good ecological status" by 2015. Water bodies that contain







Illustrations from Non-native marine species in British waters: a review and directory Ed N. Clare Eno, Robin A. Clark & William G. Sanderson, Joint Nature Conservation Committee, 1997

invasive non-native species that impact their ecology may not meet this requirement. In England, some non-native freshwater fish species, from a biogeographical point of view, have exceptional status under current legislation (e.g. common carp Cyprinus carpio, ide (or orfe) Leuciscus idus, goldfish Carassius auratus, rainbow trout Oncorhynchus mykiss). These species are considered by the authorities to be 'ordinarily resident' in England, which de facto categorizes them as being 'naturalized'.

"Non-native species find their way into our coastal waters by a variety of means, e.g. floating debris, aquaculture activities, aquatic imports and careless disposal of aquarium species (Globallast, 2002). However, the most significant mode is through shipping by attachment to hulls and in ballast water. Ballast water imports have has been identified as one of the four greatest threats to the world's oceans (Globallast, 2002). Shipping moves over 80% of the World's commodities and transfers approximately three to five billion tonnes of ballast water internationally each year" (Globallast, 2002). Coupled with the planktonic life stages of many organisms, transfer via ballast water of ships poses a real and immediate threat. "[36]

Economic cost of non-natives 7.1

In 2007 the Minister for Biodiversity stated that invasive non-native species cost the British economy approximately £2 billion per year. Economic impacts of invasive non-native species include:

- ≈ altering ecosystem services – such as causing riverbank erosion and flooding and reducing levels of biodiversity;
- ≈ inhibiting water body access – through plants forming dense stands blocking access for river users;
- ≈ affecting land developments;
- ≈ causing human health problems.

And there is no doubt that the number of invasive species is rising. A 2005 audit recorded 2,271 non-native species in England, of which 188 had a negative economic impact and 122 had a negative environmental impact[37]. Fifty-one non-native species were recorded in marine waters around Britain in 1997[38]. In 2007 the Environment Agency indicated that invasive non-native species were among the most significant water management problems in nine out of eleven river basins in England and Wales.[39]

Topmouth gudgeon

"Invasive non-native aquatic species are often of greater concern than terrestrial ones. There is little surveillance in the marine system and limited control methods available for use in both freshwater and marine systems… Chinese mitten crabs arrived in the UK in ballast water. These increase flood risk by

7 Invasive non-native species

7.1 *Economic cost of non-natives*

burrowing into and eroding estuarine banks… non-native crayfish carrying the crayfish plague which is lethal to the endangered native crayfish species…topmouth gudgeon and other non-native fish carrying parasites that threaten native fish species…"[40]

Generally speaking the reasons for non-native species establishing themselves are:

≈ Loss of natural predators and competitors from their previous habitat

≈ Better adaption to habitat that native species

≈ Disturbance of habitat (usually by human activity) to the disadvantage of native species.

Catfish

7.2 *Alien species*

Alien species can create major problems. For instance Floating Pennywort was introduced into the UK in the 1980's by the aquatic plant industry. This plant chokes waterway and ponds and causes problems for navigation and other wildlife, British Waterways removed over 6000 tonnes of this plant in 2007 from the River Soar. Control or eradication of invasive species once they are established is often very difficult due to the nature of the ecological context. For example the Environment Agency have used chemicals to remove Topmouth Gudgeon from some ponds, however these chemicals are also lethal to all other fish and invertebrates. With some species such as the American Signal Crayfish there are no chemical controls.

"The GB Programme Board has established a working group to look at the development of rapid response capability for other types of invasive species. Eradicating invasive species before they become well-established saves time and money in the long term. However, the possibility of re-invasion from external populations must also be addressed. Due to the extensive distribution of non-native invasive species and the costs involved in control programmes, it may be necessary to prioritise areas such as designated nature reserves. Current climate change predictions make it more likely that species will spread into the UK from neighbouring countries. However, many may bring with them their own pests, diseases and predators maintaining the natural balance and preventing them from becoming invasive but others may not. There is concern that climate change may allow some non-native species which are established but not invasive in the UK to become invasive. For example, red eared terrapins are found in several water bodies in Britain but it is currently too cold for them to reproduce. Warmer summers may allow this so that the terrapins become

invasive. Warmer winters will also allow cold-intolerant species to persist. Climate change may also stress native species, reducing their resilience to the impacts of invasive non-native species."[41]

Preventing the introduction of invasive species is the obvious answer however this approach has associated issues, e.g. the Ornamental and Aquatics Trade Association (OATA) estimate it would cause a £2-5million loss in their industry. Many organisations involved in addressing this problem perceive a lack of awareness of the dangers of non-native invasive species among the general public. In the absence of a national awareness programme some groups have developed awareness campaigns of their own. The OATA uses messages on its carrier bags to warn of the dangers of releasing fish or plants into the wild.

Red-eared Terrapin

Invasive Non-native Species Framework Strategy for Great Britian

7.3

These concerns have been recognised in the Invasive Non-Native Species Framework Strategy for Great Britain (Department for Environment, Food and Rural Affairs, 2008)[42] which aims to raise awareness of invasive non-native species issues among the general public and other key target audiences so that there is a wider appreciation of the risks that non-native species can pose to our native wildlife and environment. This will secure better understanding of action being taken concerning invasive non-native species enabling the public at large to assist in the detection and monitoring of invasive non-native species.

The action plan put forward suggests better public awareness through:

≈ the production and dissemination of posters, identification guides and other general literature on key invasive non-native species and related issues;

≈ the production of regular bulletins to update key stakeholders on progress in addressing invasive non-native species;

≈ partnerships, to disseminate information and raise awareness amongst important audiences;

≈ linkages and synergies with communications channels relating to pathways

Invasive non-native species

Invasive Non-native Species Framework Strategy for Great Britian

concerning human health and travel, wildlife health, trade, transport and so on;

≈ timing and targeting of communications, thematic campaigns and other suitable measures;

≈ education programmes in schools and colleges

Prevention and education are only part of the solution however and the framework strategy proposes a containment and eradication strategy based on Rapid Response Early Detection, Surveillance, Monitoring, Mitigation, Control and Eradication. Amongst the actions proposed are:

≈ Key Action 7.8 - establish (and publicise) a means for capturing information on non-native species from any source, for example, by ensuring that information from museums, government laboratories, local authority pest controllers, universities and members of the public can be passed on to the data repository;

≈ Key Action 7.9 - consider the need for investment in training and making taxonomic expertise more widely available;

An example of learning about marine issues in a safe and secure environment, the Rock Pool Zone, National Marine Aquarium, Plymouth

≈ Key Action 7.10 - identify appropriate means of securing adequate resources and capacity to carry out rapid responses to contingencies;

≈ Key Action 7.11 - establish a means for clearly designating lead agencies for rapid responses to different taxa and in different circumstances; and,

≈ Key Action 7.12 - develop a general contingency plan to include a risk assessment, mechanisms for flow of information and a protocol for rapid approval of emergency action.

In summary, invasive non-native species can have severe negative impacts on native wildlife, habitats and economic interests and the UK is obliged by several international agreements to prevent, control or eradicate invasive non-native species which are harmful. It is also apparent that climate change may exacerbate the situation, allowing species which are currently climatically limited to survive and become invasive and that this issue is a priority for the UK hence the *Invasive Non-native Species Framework Strategy for Great Britain* that will improve Britain's status in the control of such species.

Illustration from American educational website for children on invasive non-native species (www.sgnis.org)

8 / Towards a total immersion

"Conservation is a great moral issue, for it involves the patriotic duty of insuring the safety and continuance of the nation."

Theodore Roosevelt

Aims and objectives 8.1

From the evidence set out there is a clear need for projects that combine an increasing awareness of the challenges facing water based biodiversity in the United Kingdom and make use of enormous public interest in water based leisure activities. With an estimated 42 million residents of the UK looking at the water and just under 6 million getting in it there is great potential for joining ecological education to a trip to the seaside or lake or river. The educational priorities are to engender the paradigm shift needed for people to learn about their responsibilities towards the wildlife of the water and their duty to protect UK biodiversity.

Although there are many agencies working in these areas there appears to be a lack of joined up thinking. Immersion therefore will set out harness the power of recreation to ecological awareness through:

≈ Encouraging more people in the UK to understand the complex ecology of our water based environments

≈ Developing economic sustainability and promoting local water-based food and tourism industries

≈ Supporting the health of the nation by promoting free water outdoor activity to all

A time for change...

≈ Healing and protecting threatened habitats through a total immersion of public opinion

Immersion therefore proposes that a long term project is undertaken to address these aims as a matter of urgency and in order to do so sets out concrete proposals for urgent investment in our immersive infrastructure across the whole of UK. In order to start this process we have developed a national proposal that encompasses the key areas identified. In addition it is proposed that a pilot

project is undertaken to raise awareness and test the waters. Further work will be needed to realise the project but we feel that it is important to plant a flag, as the destruction of our great water heritage, ecologically, socially and economically makes this one of the most pressing matters of our time.

We have seen how the country is not using the valuable real estate left to it as a legacy of age of lidos. Many of these lidos and tidal pools are masterpieces of period architecture, ripe for regeneration and could be restored to their former glory, recycled as multi-purpose venues as combinations of aquarium, swimming pool and fish farm.

For the purposes of this project these facilities can be divided up into 5 categories:

≈ Inland facilities in use that could be diversified in purpose to include **SUSTAINABLE FRESHWATER AQUACULTURE**, generating local fish protein

≈ Inland facilities not in use, near to strategic river systems, that that could be redeveloped into **FRESHWATER INVASIVE/UNWANTED MIGRANT SPECIES REPOSITORIES**

≈ Coastal facilities in use that could be diversified in purpose to include **SUSTAINABLE MARINE AQUACULTURE**, generating local fish protein

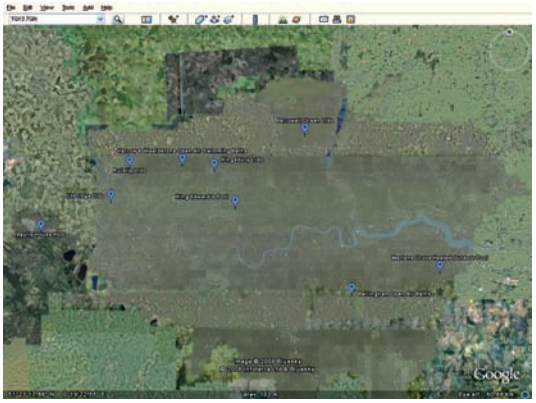
≈ Coastal facilities not in use near to strategic ports that that could be redeveloped into **MARINE INVASIVE/UNWANTED MIGRANT SPECIES REPOSITORIES**

≈ In addition there is scope for purpose built facilities that could be relocated as **RAPID RESPONSE UNITS** to areas of need.

Existing lidos in the UK tend to be limited in terms of opening times due to the variability of the English weather. Those that aren't heated tend to adopt a May to September season, remaining closed outside that period. Many of these are subsidised by local authorities and need further income to survive. It therefore seems reasonable to develop their use to combat the overfishing of UK seas and to provide sustainable freshwater aquaculture to support large industrial centres nearby.

Carp and other naturalised fish species would make ideal winter occupants for these sites when the pool is not being use for swimming. If necessary to support a longer growing season pools could be partitioned to continue to support the aquacultural function and provide new recreational opportunities for practising anglers, wild water swimmers, divers and snorkelers. This new function would add significant value to these recreational activities, allowing people to learn about the ecology of water systems whilst relaxing. Many other educational aspects to this combination could be developed, school swimming trips, hands on workshops for amateur aquaculturalists or more advanced scientific fieldwork by local universities.

Lidos with aquaculture potential, UK (for London see separate map, overleaf)



Lidos with aquaculture potential, London

LIST OF SITES
(opposite page: starting top left
& reading down in columns)

Barrowell Green Lido
Baylis House Pool
Bellingham Open Air Baths
Broomhill Swimming Pool
Clifton Pool
Eltham Park Lido

Harrow & Wealdstone Open Air
Swimming Baths
Hendy Outdoor Swimming Pool
King Edward's Pool
Kingsbury Lido
Malmesbury Outdoor Pool
Marsden Park Open Air Pool

Martens Grove Heated Outdoor
Pool
Royston Outdoor Pool
Ruislip Lido
Uxbridge Lido

Towards a total immersion

8.2.1 *Sustainable freshwater aquaculture sites*
















Freshwater invasive/unwanted migrant species repositories

In order to contain freshwater non-native species it is proposed that inland facilities are set up in order to contain species being cleared by agencies working in this field and by members of the public who have caught specimens at large. The activation and education of those members of the UK population living away from coastal areas will be a key outcome of these facilities.

Non native species, both vegetation and animal, pose a significant threat to British waterways. Plants can clog up canals and other channels used for communication, invasive crayfish have threatened British populations through direct competition and the spreading of parasites. To counter this secure facilities should be constructed at strategic sites inland, close to river and other water systems. Again disused lidos in the central belt of the UK could be reused in order to offer facilities for scientific study, general education, food and swimming/diving.

As we have seen a significant number of invasive non-native species living in UK water courses are edible, eg Catfish, Nobel Crayfish, North American Signal Crayfish, Pikeperch, Pumpkinseed, Red Swamp Crayfish, Ruddy Duck, Spiny-Cheeked Crayfish, Topmouth Gudgeon and Turkish Crayfish. In order to motivate visitors to the facility it is suggested that surplus populations of non-native species not needed for educational purposes or scientific study are put at the service of local people so that anglers can catch what they need to eat on a daily basis in ideal conditions. Several of the facilities identified have small paddling pools which could easily be adapted for children to catch specimens with hand nets. Optionally avian species such as Ruddy Duck could be used as a food crop and mammalian non-native species such as American Mink and Coypu could be used as a fur crop.

Lidos with potential as inland invasive/unwanted migrant species repositories




LIST OF SITES *(r to l): Cleveland Pleasure Baths, King's Meadow Swimming Baths, Twickenham Lido, Ynysangharad Swimming Pool*

Towards a total immersion

8.2.2 *Freshwater invasive/unwanted migrant species repositories*

Where possible the public should be involved in the maintenance of waterways through outreach programmes, catching unauthorised species in rivers and lakes. Training should be provided in the safe handling of species, particularly avoiding cross contamination with native species (as is the case with catching crayfish). Managed as sensitive tourist attractions the offer could generate the funds to maintain and staff the facilities. There would also be the option of developing local partnerships to enhance health and sport agendas. For instance local canoe clubs could offer invasive species safaris and for less adventurous boaters other, safer, options could be thought of. One concept that is in the process of development is a system of glass bottomed pedaloes which could be used for this purpose.

Prototype glass bottomed pedaloes: British Wildfowl series I

8.2.3 *Sustainable marine aquaculture*

Aquaculture is well established as an activity with 43% of global fish supply coming from farmed sources in 2004. It is therefore crucial to ensure that the effect of marine aquaculture on the environment is minimized amidst growing concern that escaped farmed stocks threaten genetic diversity and have a negative impact on the surrounding sea and sea bed. The Marine Conservation Society states that any new farms should:

≈ Minimise adverse effects on local wildlife, habitats and landscapes from pollution or poor siting;

≈ Utilise the best sustainable feed options available;

≈ Provide optimum protection of wild stocks from escapes associated with fish-farms;

≈ Continue to work towards achieving optimal health and welfare of farmed species; and

≈ Utilise the least damaging shellfish harvesting methods.

Seaside lidos and tidal pools offer the chance to create new fish farms that would be significantly better in terms of manageability,

bio-security and protection of wild fish sites. Located in seaside towns and village along the UK coast these would be accessible and educational sites, promoting sustainable tourism and encouraging the use of the coast path to the more far flung tidal pools.

Towards a total immersion

Sustainable marine aquaculture

Tinside Lido, Plymouth with the introduction of Atlantic Salmon (Salmo salar)

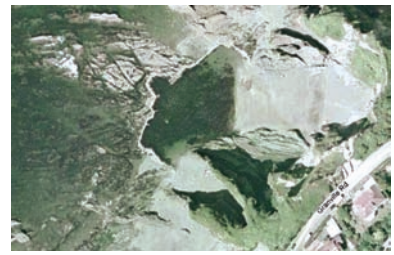
Lidos and tidal pools to consider as either sustainable marine aquaculture sites or marine invasive/unwanted migrant species repositories

Lido and tidal pool options for both sustainable marine aquaculture sites and marine invasive/unwanted migrant species repositories

Towards a total immersion

Preliminary identification of marine sites






LIST OF SITES (in columns)

Bude Tidal Pool
Clacton Pier Lido
Dancing Ledge
Grange over Sands
Havre des Pas Bathing Pool

Jubilee Pool
La Vallette Bathing Pools
Millendreath Tidal Pool
Mothecombe Beach Tidal Pool
Priests Cove Tidal Pool

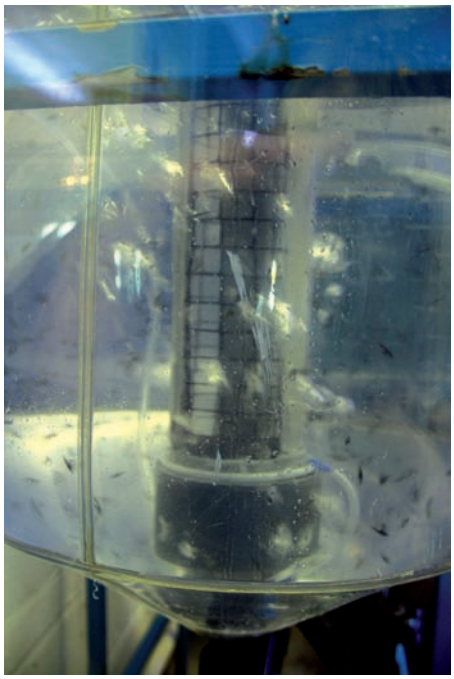
Shoalstone Beach Pool, Brixham
South Bay Lido
St. Andrew's Castle Swimming Pool
Tarlair Open Air Swimming Pool
The Lido, Worthing

Town Bay, Margate
Tunnels Beach
Walpole Bay, Margate
Westward Ho!

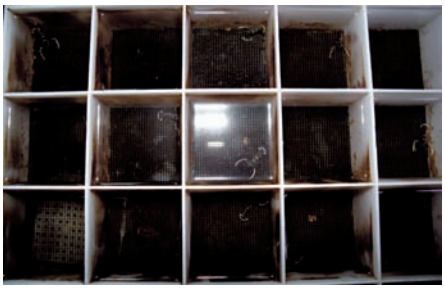
Towards a total immersion

Preliminary identification of marine sites

This type of tourism and conservation offer is being tested at Padstow in Cornwall where the Lobster Hatchery offers visitors the chance to look over the breeding facilities for local lobster. Applied to other species this idea could promote a better ecological awareness of mariculture, and the wild oceans where farmed stocks originated.



Facilities where visitors can see seafood production, then eat it, will be important as in these lobster growing tanks at the Lobster Hatchery, Padstow.



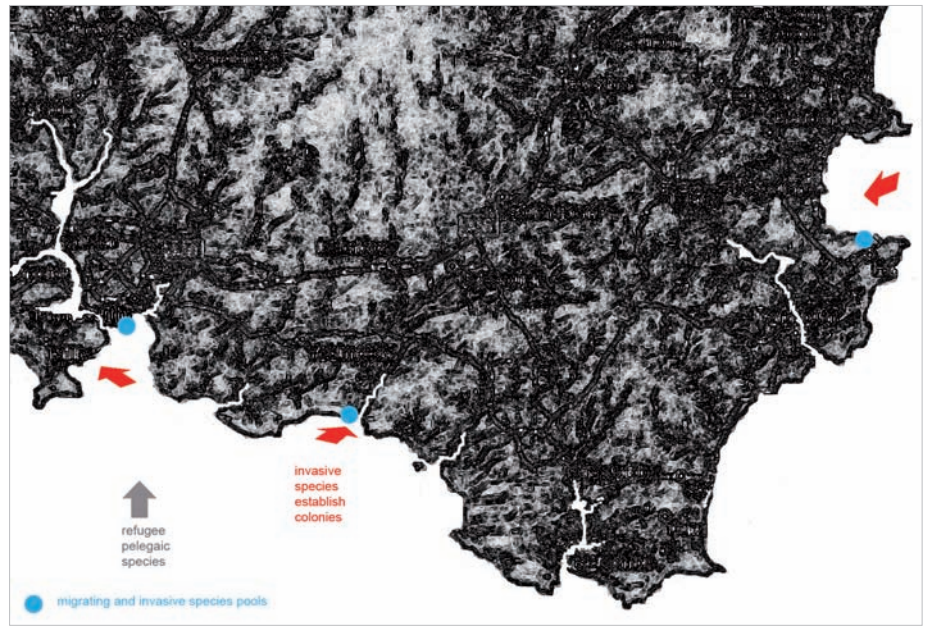
Towards a total immersion

Marine invasive/unwanted migrant species repositories

Van converted to mobile aquarium

Of the potential sites as identified above, a small number could be set aside for marine invasive/unwanted migrant species repositories operating on the same principles as the inland version. These could be supplied by local fishermen from neighbouring ports and take as their location areas in need of recreational facilities as part of regeneration initiatives, for example Plymouth and Torbay. In addition to non-native species, where appropriate, they could also display northwardly migrating pelagic species.

Secure, reinforced chassis vehicles would also be needed to transfer species from dock to facilities. These could also be used to take examples of non-native species on outreach tours to beaches and towns as a fully mobile unit.



Example of strategic location next to ports and estuaries for Marine Non-native Species Repositories on the South Devon coast

Concept design for permanent Marine Invasive/Unwanted Migrant Species Repository, restoring the tidal pool at Mothecombe, Devon

Purpose built facilities – rapid response units to areas of need

The concept design overleaf is for a rapid response unit by architects Childs Sulzmann responding to the need for a re-locatable Marine invasive/unwanted migrant species repository. A large hollowed out structure, the unit would be anchored off sites where infestations were found as its incorporated flotation tanks would enable it to be towed behind a vessel. The star shape facilitates drop off by fishing or scientific vessels who could dock alongside in order to deposit catches through the circular porthole access hatches on the top of the arms. A side entrance to the unit would allow access into the interior chambers for staff/members of the public at low tide, with access via a central top hatch at high tide.

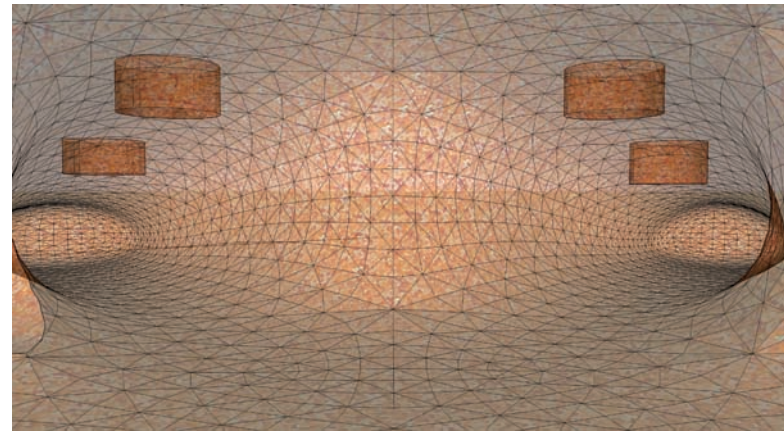
pg.54

Towards a total immersion

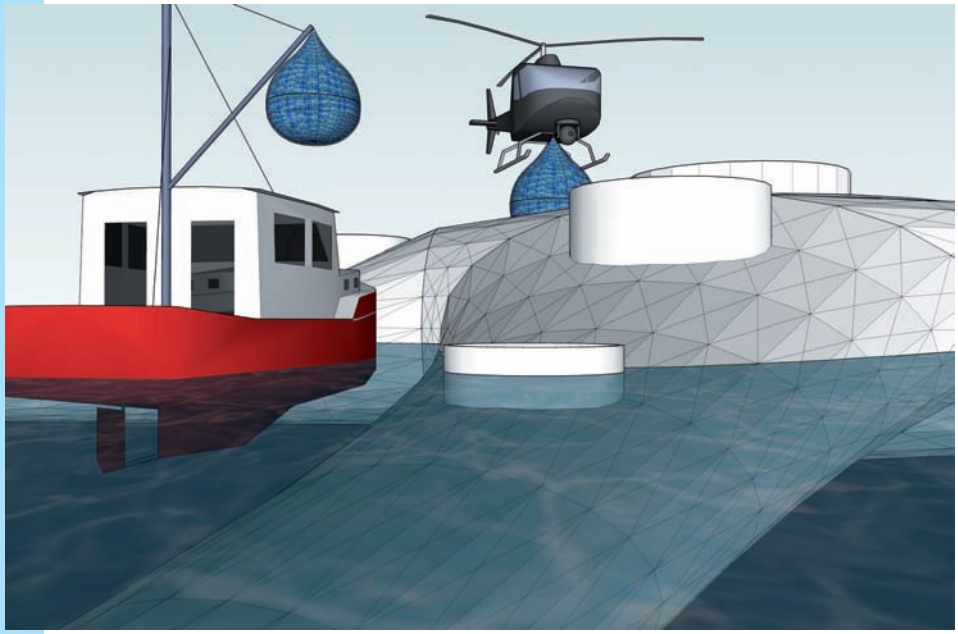
Purpose built facilities – rapid response units to areas of need

Internally the various arms would be partitioned off by glass walls in order separate resident species and to create a central access chamber which allows 360 degree supervision day and night by scientific staff. The same circular portholes used to deposit species in the various arms could also be used by members of public who wished access these different chambers to use the facility for diving or fishing.

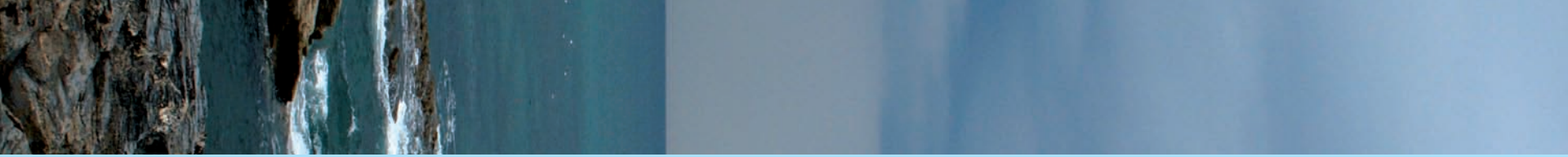
(above) external view
(below) internal view



Designs by
Childs Sulzmann
Architects



Loading a rapid response unit from sea and air



9 + 10/References, Appendices & Acknowledgements

1 Quoted in Brendon, P. Thomas Cook: 150 years of popular tourism: p.65 (1991)
2 A better place to play: Strategy for water-related sport and recreation (2006-2011), Environment Agency (2006)
3 Department for Culture, Media and Sport Game Plan. London: DCMS. (2002)
4 PAT 10 National strategy for neighbourhood renewal : Policy Action Team Audit: Report of the Policy Action Team 10: The contribution of Sport and the Arts. DCMS. London. (1999)
5 Invest in Fish South West The motivation, demographics and views of sea anglers and their Socio-economic impact on the region. (2005)
6 Sport England Economic Impact of Sport in the South West. Crewkerne: Sport England. (2007)
7 Henley Centre Potential Drivers of Change in Outdoor Recreation to 2020: A Report for Natural England's Outdoor Recreation Strategy. (2005)
8 A Strategic Plan for Water Related Recreation in the South West Region, University of Brighton for the Environment Agency (2008)
9 www.outdoorswimmingsociety.co.uk/ accessed 13 08 08
10 Watersports and Leisure Participation Survey, British Marine Federation, Maritime & Coastguard Agency, Royal Yachting Association, Royal National Lifeboat Institution (2006)
11 http://www.river-swimming.co.uk/ accessed 13 08 08
12 A better place to play: Strategy for water-related sport and recreation, Environment Agency (2006)
13 English Heritage and CABE, Shifting Sands: Design and the changing image of English Seaside Towns, (2003)
14 Framework for Action 2007-2012, South West Tourism, (2007)
15 South west bathing waters study, South West of England Regional Development Agency, (2005)
16 Public Attitudes and Values on the Coast, Cultural Dynamics, (2005)
17 South west bathing waters study, South West of England Regional Development Agency, (2005)
18 Improving coastal access: Our advice to Government, Natural England, (2007)
19 Liquid Assets: The lidos and open air swimming pools of Britain, Smith, J. (2005)
20 http://www.panda.org/about_wwf/what_we_do/marine/blue_planet/coasts/index.cfm
21 http://www.panda.org/about_wwf/what_we_do/marine/blue_planet/coasts/index.cfm
22 Eutrophication is the excessive oxygenation of water, usually caused by nitrates used for agriculture running off the land through rainfall and into rivers and oceans. This causes increased algal blooms with detrimental consequences to marine ecology.
23 Marine Biodiversity Hotspots in the UK: A report identifiying and protecting areas for marine biodiversity, Keith Hiscock & Mark Breckels (2007)
24 Sailing Trawlers: The Story of Deep-Sea Fishing with Long Line and Trawl, March, E. J. Percival Marshal and Company, p. 33.

9 References

Reprinted by Charles & David, 1970, Newton Abbot. (1953)

25 James Randerson, science correspondent, Guardian, Friday November 3, 2006 (2006)

26 Choose or lose: A recovery plan for fish stocks and the UK fishing industry, Malcolm MacGarvin and Sarah Jones December 2000, a WWF Report (2000)

27 Taste of the sea, Stein, R, (1995)

28 Principles and Criteria for Sustainable Fish Farming, Marine Conservation Society (2007)

29 The Early History of the Carp and its Economic Significance in England, Christopher Currie, Agricultural History Review, 39, II, pp 97-107

30 A discourse of fish and fishponds, R North, 1713

31 www.aquavisiononline.com accessed 13 08 08

32 www.spc.int/corp/ Secretariat of the Pacific Community accessed 13 08 08

33 Marine Life of Britain and Climate Change – Press release for the National Marine Aquarium, Herdson, D, (2007)

34 Science Magazine, 24 JUNE 2005 VOL 308 www.sciencemag.org

35 Non-native marine species in British waters: a review and directory Ed N. Clare Eno, Robin A. Clark & William G. Sanderson, Joint Nature Conservation Committee, (1997)

36 Barton, E. & Heard, J. Marine Life Topic Note. Alien, Non-native and Invasive Marine species. Marine Life Information Network [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: http://www.marlin.ac.uk/learningzone/ (1953)

37 English Nature. Audit of non-native species in England. (2005)

38 Eno, N.C. et al. JNCC review. (1997)

39 Invasive Non-Native Species, The Parliamentary Office of Science and Technology, postnote Number 303 (April 2008)

40 Dr Niall Moore, Non-native Species Secretariat.

41 Invasive Non-Native Species, The Parliamentary Office of Science and Technology, postnote Number 303 (April 2008)

42 www.nonnativespecies.org

43 Keith Hiscock & Mark Breckels, Marine Biodiversity Hotspots in the UK: A report identifiying and protecting areas for marine biodiversity (2007)

Some common fisheries that are potentially unsustainable

Atlantic and North Sea cod

All north-east Atlantic cod stocks are assessed as being overfished, however stocks in the North Sea, Irish Sea, West of Scotland, eastern Channel, eastern Baltic, Greenland, Skaggerak, Kattegat and Norwegian coast are the most heavily depleted.

Atlantic halibut

Atlantic halibut is a thick-set, flat fish with both eyes on the right-hand side of the body. It lives in deep, cold waters and is slow-growing. Atlantic halibut is overfished, which means it is caught in such high numbers that a sustainable fishery cannot be maintained by the current population size. It is also assessed by the International Union for Conservation of Nature (IUCN) as endangered.

Dogfish

Spiny dogfish, spurdog, rock salmon or flake are all species of dogfish, which belong to the same family as sharks and rays. Spurdogs are long-lived, slow growing and have a high age of maturity. The north-east Atlantic stock is now considered to be depleted and may be in danger of collapse. Species also assessed as critically endangered by the IUCN.

European eel

Eels spawn in the sea and return to freshwater streams to grow. The European eel breeds in the mid-Atlantic Sargasso Sea. There is one single European eel stock. This is severely depleted and at a historical minimum which continues to decline. Eels spawn only once in their lifetime and it is almost certain they die after spawning. Eels are also farmed but rely on juveniles from wild stocks.

European hake

There are two main stocks for European hake - a northern and southern stock. The northern stock is below the minimum biomass level recommended by marine scientists but harvested sustainably, and the southern stock is depleted. Avoid eating hake from depleted stocks and immature fish below about 50cms and during their breeding season, which is February to July.

Porbeagle

Porbeagle is part of a group of sharks known collectively as mackerel sharks. Sharks are vulnerable to exploitation because they are slow-growing, long-lived, and have low reproductive capacity. Porbeagle is assessed as critically endangered by the IUCN. Its north Atlantic population was seriously over-exploited by directed long-line fisheries up until the 1970s, when they became unprofitable. Since then there have been sporadic targeted fisheries for porbeagle and they are also caught as bycatch. You should avoid eating any species of shark, which are caught not only for their meat but also for their fins. Shark-finning, for the Asian shark-fin soup market, is a wasteful and barbaric technique where fins are hacked off and sharks thrown back into the sea to die.

10 Appendices

10.1 *Some common fisheries that are potentially unsustainable*

Plaice

Plaice is a long-lived species and subject to high fishing pressure. Stocks in the Celtic Sea, western Channel, south-west Ireland and the west of Ireland are in decline and substantial reductions in fishing efforts are required to achieve sustainable stock levels. Large numbers of undersized plaice are discarded in particular in areas of the southern North Sea that are trawled for sole and plaice. The Irish Sea stock is currently the only stock classified as healthy and harvested sustainably. Avoid eating immature plaice below 30cm and during their breeding season, from January to March.

Seabass

You should avoid eating seabass captured by nets that trawl the bottom of the sea. These fisheries target spawning and pre-spawning fish, are responsible for high levels of dolphin by-catch, and deplete stocks available for inshore and recreational fisheries. Choose fish which has been sustainably caught by handlining methods in the south-west of England.

Skate

The common skate is the largest European flat fish, with females reaching lengths of 285cm and males 205cm. They are found in the north-east Atlantic from Madeira and northern Morocco to Iceland and northern Norway. Common, long-nose, black and white skate are all endangered species.

Sole

North Sea Dover or common sole stock is classified as healthy and harvested sustainably. Stocks in Skaggerak and Kattegat, the Eastern Channel and Celtic Sea are also healthy but the level of fishing pressure is considered too high or unknown. Stocks in the Western Channel and Biscay are below the minimum level recommended by scientists and harvested unsustainably. Avoid eating fish caught in these areas, as well as south-west Ireland, where the state of the stock is unknown and catches the lowest on record. Dover sole from the Hastings Fleet trammel net fishery in the Eastern Channel is certified as an environmentally responsible fishery. Avoid eating immature sole (less than 28cm) and fish caught during the breeding season (April-June).

Whitebait

Whitebait are the fry (young) of herring and sprat. As with any fishery's future, sustainability relies on young fish being allowed to mature and reproduce to maintain the population. Taking juveniles before they have a chance to spawn undermines future sustainability.

Unsustainable fisheries

1. Alfonsinos or golden eye perch
2. American plaice
3. Argentine or greater silver smelt
4. Atlantic cod (from overfished stocks)
5. Atlantic halibut
6. Atlantic salmon (wild caught)
7. Black Scabbardfish (trawled from Northern Stocks)
8. Blue ling
9. Brill (beam-trawl caught from the North Sea)
10. Patagonian toothfish (non MSC certified fisheries)
11. Nursehound (bull huss, dogfish, flake, greater spotted dogfish) and Spurdog (piked dogfish, rock salmon, spiny dogfish)
12. European Hake
13. Greater forkbeard
14. Grouper
15. Ling
16. Marlin (blue, Indo-Pacific & white)
17. Monkfish (from North and North West Spain, Portuguese Coast)
18. Orange roughy
19. Plaice (from overfished stocks)
20. Rat or rabbit fish
21. Red or blackspot seabream
22. Redfish or ocean perch
23. Roundnose grenadier
24. Seabass (trawl caught only)
25. Shark
26. Skates and Rays (except mature cuckoo, spotted and starry rays)
27. Snapper
28. Sturgeon
29. Swordfish
30. Tiger prawn (except organically farmed)
31. Tuna (except dolphin friendly, pole and line caught yellowfin and skipjack)
32. Turbot (from North Sea)
33. Tusk or torsk
34. Wolfish

Taken from www.fishonline.org, a Marine Conservation Society website

Sustainable fisheries

1. Abalone (farmed)
2. Alaska or walleye pollock (MSC certified from Alaska)
3. Bib or pouting
4. Black bream or porgy or seabream (from Cornwall and NW and N Wales)
5. Brown crab (pot caught off S Devon coast)
6. Cape hake (MSC certified from S Africa)
7. Clam (sustainably harvested)
8. Cockle (MSC certified from Bury Inlet, SW Wales)
9. Cod, Atlantic (organically farmed)

Appendices

Sustainable fisheries

10. Cod, Pacific (MSC certified)
11. Coley or saithe (from NE Arctic and combined N Sea stock)
12. Dab
13. Dover sole (MSC certified from Eastern Channel)
14. Flounder (from Cornwall and NW and N Wales)
15. Gurnard (grey and red)
16. Halibut, Pacific (MSC certified)
17. Herring or sild (MSC certified from Thames Blackwater, North Sea and Eastern English Channel)
18. Lemon sole (otter trawled from Cornwall)
19. Lobster, Mexican Baja California red rock (MSC certified)
20. Lobster, Western Australian rock (MSC certified)
21. Lythe or pollack (line caught and tagged from Cornwall))
22. Mackerel (MSC certified from Cornwall))
23. Mahi Mahi (handline caught from targeted fisheries only)
24. Mussel (sustainably harvested or farmed e.g. rope grown))
25. Oyster (native & Pacific, sustainably farmed)
26. Pilchard or sardine, European (traditionally harvested from Cornwall)
27. Red mullet (not from Mediterranean)
28. Salmon, Atlantic (Organically farmed)
29. Salmon, Pacific (MSC certified from Alaska)
30. Scallop (sustainably harvested e.g. dive-caught)
31. Scampi or Dublin Bay prawn (MSC certified from Loch Torridon, NW Scotland (not available in UK))
32. Scampi or Dublin Bay prawn (pot-caught from West of Scotland)
33. Seabass (line-caught and tagged from Cornwall)
34. Snapper, Red or Crimson
35. Spider crab (pot caught only)
36. Tilapia (sustainably farmed)
37. Trout (brown or sea and rainbow, organically farmed)
38. Tuna, albacore (pole and line, handline or troll-caught from S Pacific or S Atlantic)
39. Tuna, skipjack (pole and line or handline-caught from Pacific (western & central) or Maldives)
40. Tuna, yellowfin (pole and line, handline or troll-caught from Pacific (western & central) or Atlantic)
41. Whiting (from English Channel)
42. Winkle (sustainably harvested e g. hand picked)

Migrating marine species

Some southern migrants moving north:

Red Mullet Mullus barbatus
Smooth pufferfish Pachygaster sphoeroides
Flying Gurnard Dactylopterus volitans
Grey triggerfish Balistes capriscus
Ocean Sunfish Mola mola
Vadigo Campogramma glaycos
Greater Amberjack Seriola dumerili
Derbio Trachinotus ovatus
Almaco Jack Seriola rivolianna
Blue Runner Car ysos
Amberjack Seriola sp.
Guinea Amberjack Seriola carpenteri
Derbio Trachinotus ovatus
Gilthead Sea Bream Sparus aurata
Couch's Sea Bream Pagrus pagrus
Bogue Boops boops
Saddled Sea Bream Oblada melanura
Spanish Sea Bream Pagellus acarne
Zebra Sea bream Diplodus cervinus
White Sea Bream Diplodus sargus
Red Scorpionfish Scorpaena scrofa
Small-scaled Scorpionfish Scorpaena porcus
Triton Charonia lampas
Slipper Lobster Scyllarus arctus
Tiger Prawn Penaeus japonicus

Source: National Marine Aquarium

Non-native freshwater plants and animals in the UK

10.5

American Bullfrog Rana catesbeiana
American Mink Mink Mustela
Australian Swamp Stonecrop Crassula helmsii
Australian Swamp Stonecrop Tillaea recurva
Australian Swamp Stonecrop Tillaea helmsii
Catfish Siluris glanis
Coypu Myocaster coypus
Curly Water Weed Lagarosiphon major
Curly Water Weed Elodea crispa
Floating Pennywort Hydrocotyle ranunculoides
Nobel Crayfish Astacus astacus
North American Signal Crayfish Pacifastacus leniusculus
Parrot's feather Myriophyllum aquaticum
Pikeperch Sander lucioperca,
Pumpkinseed Lepomis gibbosus
Red Eared Terrapin Trachemys scripta
Red Swamp Crayfish Procambarus clarkii
Ruddy Duck Oxyura jamaicensis
South American Water Primrose Ludwigia grandiflora

Spiny-Cheeked Crayfish Orconectes limosus
Topmouth Gudgeon Pseudorasbora parva
Turkish Crayfish Astacus leptodactylus
Water Fern Azolla filiculoides
Water Hyacinth Eichhornia crassipes
Water Lettuce Pistia stratiotes
Water Primrose Ludwigia peploides
Zebra Mussel Dreissena polymorpha
Curly Waterweed Lagarosiphon major

10.6 *Non-native marine species in British Waters*

Taken from Non-native marine species in British waters: a review and directory Ed N. Clare Eno, Robin A. Clark & William G. Sanderson, Joint Nature Conservation Committee, 1997

Entries are made in the following order: Name, Common name, Effects on the environment, Effects on commercial interests, Control methods used and effectiveness, Beneficial effects, Comments

FLORA

Bacillariophyta Thalassiosira punctigera
A centric diatom
Unknown.
Unknown.
None used.
None known.
It is an extremely variable species with regard to size and valve structure (Hasle 1983). It was very abundant in the English Channel in the period 1980-1981 but has subsequently been considered to have an insignificant role (Boalch 1987).

Thalassiosira tealata
A centric diatom
Unknown.
Unknown.
None used.
None known.
The sample containing Thalassiosira tealata was collected near Blakeney, Gloucestershire from the river Severn in 1950, but not examined at that time. Its presence in European waters was known for some years (G.R. Hasle pers. comm.) but the species was not described until 1980 by Takano.

Coscinodiscus wailesii
A centric diatom
It can reach high numbers and produce copious mucilage which 'in sinking' can accumulate insoluble skeletons of planktonic organisms and mineral particles, increasing its volume and density (Boalch & Harbour 1977) and blanket the seabed.
Fishing trawls may become clogged or broken by heavy grey slime. It may interfere with the hauling of fishing gear and prolonged washing or air drying may not com-

pletely remove it (Boalch & Harbour 1977).
None used.
None known.
Boalch (1987) reported Coscinodiscus wailesii to be still present in the Plymouth area and to have become a major constituent of the winter centric diatom population.

Odontella sinensis
A centric diatom
This species has been a prominent contributor to the winter and spring phytoplankton of the western English Channel (Boalch & Harbour 1977; Boalch 1987).
Unknown.
None known.
None.
None.

Pleurosigma simonsenii
A pennate diatom
Presumably Pleurosigma simonsenii has displaced native species at times since it was reported dominant in the Plymouth area in 1973; it has since 'settled down' to a minor constituent of the plankton (Boalch & Harbour 1977b; Boalch 1987; Wallentinus in press).
Unknown.
None used.
None known.
Currently it is considered a minor constituent of the British phytoplankton (Boalch & Harbour 1977a).

Rhodophyta Asparagopsis armata
Harpoon weed
Unknown.
Unknown.
None used.
None known.
There are two macroscopic phases to the life cycle of Asparagopsis armata, the filamentous habit being very similar in appearance to that of Bonnemaisonia hamifera but readily distinguished at the cellular level (D.A. Birkett pers. comm.).

Bonnemaisonia hamifera
None
Unknown.
Unknown.
None used.
None known.
There are two macroscopic phases to the life of this species, the filamentous Trailliella "pink cotton wool" phase being very difficult to distinguish from the same life phase of related species (D.A. Birkett pers. comm.).

Grateloupia doryphora
None
Unknown.
This species is used in the Pacific as a food and as an industrial source of carrageenan.
None.
None known.
Where the two co-exist, G. doryphora usually out competes the other non-native, G. filicina var. luxurians (W.F. Farnham pers. comm.). The ribbon-like blades of this seaweed can reach a size of 100 cm by 20 cm, but are usually much smaller (Irvine & Farnham 1983).

Grateloupia filicina var. luxurians
None
Unknown, but see under comments.
It grows in marinas but is unlikely to be a nuisance.
None used.
This species is used in the western Pacific as a food and as a source of carrageenan.
The fronds of this seaweed can reach a length of 70 cm (Irvine & Farnham 1983), compared with up to 10 cm for the native variety G. filicina var. filicina. The non-native may be capable of displacing other species, on account of its potential size (R. Mitchell pers. comm.) although there is no indication of this happening (W.F. Farnham pers. comm.).

Pikea californica
Captain Pike's weed
Possible displacement of native species, but likely to be insignificant.
Unknown.
None used.
None known.
In order to recognise this species, examination of the distinctive anatomical detail is required (D.A. Birkett pers. comm.). Recent research has shown that Japanese populations of 'Pikea californica' are in fact another species (Maggs & Ward 1996).

Agardhiella subulata

None
Unknown.
Unknown.
None used.
It may be a potential source of carrageenan (W.F. Farnham pers. comm.).
Taxonomic research remains to be done to establish which species this is and thereby indicate where it has come from (e.g. see Farnham 1980). The species present in the Solent may be Neoagardhiella gaudichaudii, not A. subulata but W.F. Farnham (pers. comm.) recommends acceptance as A. subulata for now.

Solieria chordalis

None
None known.
Unknown.
None used.
It could be cultivated to produce carrageenan.
Previously it was considered that, as well as Solieria chordalis on the south coast, Solieria filiformis was present in Milford Haven, South Wales. However, W.F. Farnham (pers. comm.) indicates that the Milford Haven population (Farnham 1980; Farnham & Irvine 1979) was misidentified and is probably better referred to as S. chordalis (the only known species of this genus in Britain).

Antithamnionella spirographidis

None
Unknown.
It may cause fouling in marinas.
None used.
None known.
Wollaston (1986) commented that Antithamnionella spirographidis was introduced into Australia from Europe by shipping and it is associated with dockyards and harbours. In their natural habitats, Antithamnionella spirographidis and A. ternifolia are very similar in appearance so microscopic examination is required to distinguish them (Maggs & Hommersand 1993).

Antithamnionella ternifolia

None
No effects are known.
It is a fouling organism.
None used.
None known.
More taxonomic research is required to determine whether other southern hemisphere species are conspecific. In their natural habitats, Antithamnionella spirographidis and A.ternifolia are very similar in appearance so microscopic examination is required to distinguish them.

Polysiphonia harveyi

None
It possibly displaces native species as it can become very abundant.
It is a fouling agent as it is abundant in marinas on artificial structures, but as it is small, this is not a significant problem.
None used.
None known.
Japanese populations are interfertile with British populations of Polysiphonia harveyi (C.A. Maggs pers. comm.), but the correct taxonomy is still to be determined, possibly involving Polysiphonia strictissima (described from New Zealand). All species of Polysiphonia require microscopic examination to confirm their identification.

Chromophyta Colpomenia peregrina

Oyster thief
It has negligible effects on the environment.
When growing attached to oysters it floats away with the oyster when the air-filled thalli grow large enough, hence its name of oyster thief (Farnham 1980) but this does not occur in England.
None used.
None known.
It is found almost world-wide in temperate areas. There is some debate as to whether Colpomenia peregrina and C. sinuosa are separate species or variants of a single species.

Undaria pinnatifida

Wakame (in Japan), Japanese kelp
It may cause displacement of other native species (Fletcher & Manfredi 1995).
Undaria is a commercially important edible species. It is a fouling agent.
It is planned to remove all subsequently occurring plants from the marina pontoons in the Hamble. However, this is thought unlikely to eradicate the species or halt its local

spread (Fletcher & Manfredi 1995).
Undaria is a commercially important species, cultivated for food (Guiry & Blunden 1991).
The intentional introduction of Undaria to the north coast of France and its continued farming has been considered extensively and sanctioned by the International Council for the Exploration of the Sea. Proposals to introduce this species to Ireland were rejected (Wallentinus in press).

Sargassum muticum

Jap weed, wire weed, strangle weed
It causes the physical displacement of native species through over-growing and shading underlying species (Critchley, Farnham & Morrell 1986). There is documented replacement of Laminaria saccharina and Zostera marina at Grandcamp on the French Atlantic coast (Givernaud, Cosson & Givernaud-Mouradi 1991). In Britain, there is observed growth of Sargassum on eel-grass beds in the Isles of Scilly (Raines et al. 1992) and in deep pools and channels Halidrys siliquosa can be displaced by Sargassum muticum as the dominant species (George, Tittley & Wood in prep.). Withers et al. (1975) reported a rich epiphytic community associated with Sargassum collected from the east Solent, suggesting that native epiphytic species are not particularly affected.
This species is a pest and fouling organism which is reported to interfere with recreational use of waterways, particularly when it becomes detached from hold fasts and floats off forming large masses (Farnham 1980). It blocks propellers and intakes (Critchley, Farnham & Morrell 1986). It is also a fouling organism on oyster beds and a nuisance to commercial fishermen, fouling their nets (Critchley, Farnham & Morrell 1981).
Removing Sargassum by hand is extremely time-consuming and needs to be repeated, probably indefinitely (Farnham 1980). Removal by trawling, cutting and suction have also been tried. Chemical methods using herbicide have been tried but failed due to lack of selectivity and the large doses needed. Small germlings can be consumed by molluscs and amphipods but this has no restrictive effect on S. muticum. Whatever method is used the alga always quickly regrows and effective methods for its permanent removal have not been found, although cutting and suction is the preferred method applied (Farnham et al. 1981; Critchley, Farnham & Morell 1986).
It is of possible commercial value to the alginate industry. In its native habitat off the coast of Japan S. muticum is much smaller than in Britain (Rueness 1989). The eradication of this species in British waters has been attempted but has failed.

CHLOROPHYTA

Codium fragile subsp. atlanticum

Green sea fingers
It displaces the native species Codium tomentosum (Farnham 1980).
Unknown.
None used.
It is eaten in the Far East.
The subspecies of C. fragile found in Britain are only distinguishable microscopically. This has resulted in uncertainty as to when they were introduced and how they have spread. A third subspecies, scandinavicum, was introduced to Denmark in 1919 and Norway from Asiatic coasts of the Pacific.

Codium fragile subsp. tomentosoides

Green sea fingers
It displaces native species Codium tomentosum (Farnham 1980) although there is some recent indication that the native Codium tomentosum is making a comeback against this non-native (W.F. Farnham pers. comm.).
It is used as a food in the Far East.
None used.
None known.
See comments on C. fragile subsp. atlanticum.

Anthophyta Spartina anglica

Common cord-grass, Townsend's grass or ricegrass.
The rapid colonisation of Spartina over extensive flats in sites with large wintering populations of waders and wildfowl is a major concern because of the birds' loss of habitat for feeding and roosting (Davidson et al. 1991). It is believed that Spartina anglica may have helped the die back of the native S. maritima as the latter is much less widely spread than formerly (Perring & Walters 1976). In addition, by taking over the mantle of the native pioneer species, S. anglica has altered the course of succession. It usually produces a monoculture which has much less intrinsic value to wildlife than the naturally species-diverse marsh (Davidson et al. 1991).
Amenity interests may be affected, though it has been used in the past as an aid to saltmarsh enclosure.

Appendices

Non-native marine species in British waters

Before World War II, copper sulphate was sprayed on Spartina as a treatment (Hardy 1968). More recently there have been several attempts to control Spartina anglica where it has invaded nature reserves (Doody 1984) by spraying it with the herbicides Dalapon and Feneron, and attempts have also been made to dig up seedlings. Dalapon is reported to have been up to 80% successful, but is generally considered to be not very effective. Pesticide trials have been carried out at Lindisfarne National Nature Reserve off the Northumberland coast and at several other sites.
The ability of Spartina to colonise open mudflats at a faster rate, and further seaward, than its competitors has been seen as of potential benefit to man. As a consequence it was extensively planted throughout Britain (Hubbard & Stebbings 1967), in Europe, and even as far as China, as an aid to stabilisation of coastlines and a stimulus to enclosure and land-claim (Davidson et al. 1991).
Spartina anglica is now the main species of cord-grass found throughout Great Britain.

FAUNA

Cnidaria Gonionemus vertens

None
Unknown.
Unknown.
None used.
None known.
It is unlikely that the venom of Gonionemus vertens is as harmful to humans as in much studied Gonionemus populations of Far-Eastern Russian waters (see Cornelius (1995) and references therein).

Clavopsella navis

None
Unknown.
Unknown.
None used.
None known.
None.

Haliplanella lineata

Orange-striped sea anemone
Unknown.
It can possibly be a nuisance as a fouling organism.
None used.
None known.
The species is now a common brackish-water anemone in Britain (Barnes 1994).

Nematoda Anguillicola crassus

Swim-bladder nematode
Common eels Anguilla anguilla, if infected by Anguillicola crassus, can show adverse effects if the level of infestation is high. These include higher susceptibility to bacterial infections and death. The wall of the swim bladder may thicken and inflammation occur. Growth may slow and damage to the swim bladder may prevent the spawning migration to the western Atlantic (Køie 1988). Kennedy & Fitch (1990) document the occurrence of these effects in eels in British waters.
In eel farms the parasites have been observed to cause reduction in growth rate. The wall of the swim bladder of highly infected eels may burst (Mellergaard 1988).
No information is available.
None known.
This species is normally found in freshwater conditions, and brackish waters up to 20‰ salinity. However, it has been recorded in hosts in the open sea.

Annelida Goniadella gracilis

None
Unknown.
Unknown.
None used.
None known.
It appears that Goniadella gracilis has become quite common in Liverpool Bay in sandy gravel below 15 m water depth.

Marenzelleria viridis

None
In the Tay, M. viridis occurred at greater sediment depths than other species in an intertidal mudflat, yet its distribution and population densities were negatively correlated with all other species (Atkins, Jones & Garwood 1987). In the Ems estuary in The Netherlands, increasing densities of Marenzelleria viridis in a sandy habitat coincided with a reduced abundance of the polychaete Hediste diversicolor, and density fluctuations of M. viridis and the amphipod Corophium volutator showed a significant positive relationship (Essink & Kleef 1993). However, the

cause of these effects is not understood, and may be environmental factors rather than species interactions. Recent studies in the Ems estuary by Essink, Eppinga & Dekker (in prep.) demonstrated an inverse abundance and biomass relationship between the introduced spionid polychaete M. viridis and the previously most abundant native polychaete Hediste diversicolor, indicating that competition occurs between the two species.
None.
None used.
None known in Britain. In the Ems, M. viridis is preyed upon by plaice Pleuronectes platessa and flounder Platichthys flesus (Essink & Kleef 1993).
The biology of this species has been studied in the Tay estuary in Britain (Atkins, Jones & Garwood 1987) and various sites in mainland Europe, including the Ems estuary (Essink & Kleef 1993). There are also extensive studies (on the ecology, physiology, genetics, larval ecology and reproduction) of the species underway in German Baltic waters at the University of Rostock, Institute of Baltic Sea Research (K. Essink pers. comm.).

Clymenella torquata

Bamboo worm
None.
None.
None used.
None.
Pilgrim (1965) commented that individuals collected from Whitstable were 15 cm long while those from Beaufort, North Carolina, USA, were only 6 cm long, but were otherwise the same.

Hydroides dianthus

A tubeworm
Unknown.
It is a fouling organism. Nelson & Stauber (1940) reported that Hydroides dianthus may kill young oysters (Crassostrea virginica) by overgrowing them in its native area of eastern North America. It is also the host of certain nematode stages in eastern North America.
It can be removed by scraping of buoys and ships' hulls.
Its effects are negligible but see under H. ezoensis and F. enigmaticus.
While it is possible that H. dianthus has been present in British waters for some considerable time (Zibrowius & Thorp 1989), it is known from only a few specimens collected from Southampton Water (Thorp, Pyne & West 1987; Zibrowius & Thorp 1989).

Hydroides ezoensis

A tubeworm
It has unknown effects, although perhaps some displacement of 'waterline' green algae Ulva and Enteromorpha occurs (C.H. Thorp pers. comm.). It has not displaced the heavy sea-squirtdominated fouling community at an immediately lower level.
It is a severe fouling organism on harbour structures and ships' hulls throughout Southampton Water. While this additional fouling load does not appear to have had any deleterious effect on fixed harbour structures, it has caused flotation problems of buoys and added considerably to fouling of poorly-protected ships.
It can be removed by scraping of buoys and ships' hulls.
It probably adds to the diversity and success of indigenous species. Within the bulk of its massive encrustations (30 cm thick (Thorp, Pyne & West 1987)) is a protected habitat for freeliving and sessile invertebrates (C.H. Thorp pers. comm.). It provides food: the opercula and branchial crown are eaten by fish predators, and larvae and eggs are produced in very large numbers, food for filter-feeders (C.H. Thorp pers. comm.).
This massive introduction, initiated almost certainly in 1976, passed without comment until specimens were removed from the hull of a fouled tug in 1982. Although enquiries elicited the information that heavy tube-worm fouling had been observed in 1980, and perhaps earlier, it was only the 'accident' of a research student collecting fouling algae that brought the massive encrustations to light.

Ficopomatus enigmaticus

A tubeworm
Its effects on native species are more likely to be beneficial than problematic (see below). This species favours waters which present some degree of stress to most open-shore marine organisms. Its requirement for variable-salinity water in which to spawn ensures that the major populations do not interfere with most indigenous species.
It is a fouling species which affects ships, buoys and harbour structures.
It is removed from buoys and ships' hulls by scraping.
While F. enigmaticus can be a fouling nuisance it can

also benefit the waters it invades. As Keene (1980) and Davies, Stuart & Villiers (1989) have shown, the presence of large numbers in enclosed waters including marinas, where they would be considered a fouling nuisance, has had very beneficial effects on water quality, reducing suspended particulate loads and improving both the oxygen and nutrient status. Thomas & Thorp (1994) have also shown that a large population of F. enigmaticus can remove material from suspension and thus have a very beneficial effect on other benthic species within enclosed or semi-enclosed waters. However, abundant filter-feeders can also deplete phytoplanktonic resources and suspended particulate organic material which might otherwise be utilised by other, native, filter-feeders. Through production of faeces and psuedofaeces in large quanities they also concentrate contaminants from the water column and pass them into the sediment and hence up the food chain.
Recorded initially in 1937 from Weymouth Harbour, Dorset, and within adjacent Radipole Lake in 1952 (Tebble 1953, 1956), this species has been noted there on a number of widely separated occasions over subsequent years. Lack of data render it impossible to determine whether the population in 1937 had survived through many generations for more than 50 years, or whether its observed presence represents a series of discrete invasions, each of which lasted a finite period.

Janua brasiliensis
A tubeworm
In the Goes Canal the density of the settlement of J. brasiliensis on the eel grass Zostera was great enough to have weighed down leaves such that lay on the canal sediment. This considerably impaired the eel grass' photosynthetic efficiency (Critchley & Thorp 1985).
It is a fouling organism but has negligible effect in British waters.
Not applicable to such a small animal.
None known.
All three records of J. brasiliensis from European waters have come about as a consequence of monitoring the spread of S. muticum, in the case of the Goes record in particular. It is possible that there are other sites with isolated populations on Channel coasts, both French and English, which have not been visited by competent 'spirorbidologists'. Such sites would be situated in the vicinity of warmed water, coastal power plants etc.

Pileolaria berkeleyana
A tubeworm
Unknown.
Unknown.
None warranted on such a small animal.
None known.
This species, like Janua brasiliensis, has been recorded only through the monitoring of the nonnative alga S. muticum, and it is therefore likely that there are other sites where this species is present but has not been recorded. In fact, C.H. Thorp (pers. comm.) considers it is likely that this species has spread more widely than J. brasiliensis.

Chelicerata Ammothea hilgendorfi
A sea spider
None.
Unknown.
None.
None known.
This is a species of no ecological or commercial significance. Introduction to the lagoon in Venice is also presumed to have been on a ship's hull. Chocolate brown markings on the trunk and legs (as indicated in the illustration) are a useful aid to identification.

CRUSTACEA

Elminius modestus
None
In northern areas, such s the British Isles, Elminius modestus competes with Semibalanus balanoides (Crisp 1958), whereas in southern Europe it competes with Chthamalus species as well. E. modestus is, however, also found in low or variable salinity habitats where native S. balanoides does not survive. Balanus improvisus seems to be retreating where it is in competition with E. modestus (Crisp 1958; Hayward & Ryland 1990). Balanus improvisus may have been displaced from the Tamar estuary, Devon and Cornwall, and become extremely rare in the Dart, Devon, as a result of competition from E. modestus (A. Southward pers. comm.). It has been suggested that since it produces a larger number of larval stages in the summer than S. balanoides, it may be in direct competition with other components of the zooplankton, notably the larval stages of other benthic species (Crisp 1958; Farnham 1980).
It is a fouling organism in favourable conditions.
Ships' hulls and buoys are scraped to remove barnacles.

None known.
None.

Balanus amphitrite
None
Unknown.
It is a fouling organism.
None used.
None known.
None.

Acartia tonsa
None
Unknown.
None.
None used.
None known.
This species produces diapause eggs (Zilhoux & Gonzalez 1972) which may have helped with transport in ballast waters.

Eusarsiella zostericola
None
No effects known.
None.
None used.
None known.
It is one of the many species introduced with American oysters. It is probably present in other estuaries, but as it is not present in British keys it is likely to be mis-identified or not identified. Although it is small in size, yet will be retained on 0.5 mm sieves, it is larger and more fecund than those of studied North American populations (Bamber 1987b).

Corophium sextonae
None
It has apparently negligible effects, although Spooner (1951) considered that its increase in abundance in the Plymouth area was linked to a decrease in abundance of the native Corophium bonnellii (not used for other sp.).
Unknown.
None used.
None known.
None

Eriocheir sinensis
Chinese mitten crab
For most of its life E. sinensis lives in fresh water. During August adult crabs migrate seawards and gather in large swarms to breed in estuaries (Panning 1939). When population densities are high, E. sinensis causes considerable damage to soft sediment banks through burrowing which increases erosion and might affect flood defences.
This species is an intermediate host for the mammalian lung fluke Paragonimus ringer.
It may damage the nets of eel fishermen. Damage caused to river banks may increase repair costs.
Those caught in eel nets are destroyed. It may be possible to use biological control through maintenance of fish populations leading to increased predation.
Parasite-free individuals, have a small commercial value: In the Japanese restaurant market E. sinensis was worth £20/kg in 1995.
Increases in population in the Thames in recent years may be attributable to drought conditions during 1989-1992 having facilitated greater settlement of young crabs (Atrill & Thomas in press). Adults occupy an essentially freshwater habitat but must migrate to mate and release larvae in the saline mouths of estuaries, congregating as they do so. Young crabs in turn migrate up estuaries (Barnes 1994).

Rhithropanopeus harrisii
Zuiderzee crab, dwarf crab
Unknown
Unknown
None used.
None known.
Cardiff Docks harbour other non-native species, including the tube worm Ficopomatus enigmaticus, with which R.. harrisii may associate, possibly on trophic levels.

MOLLUSCA

Crepidula fornicata
Slipper limpet
It competes with other filter-feeding invertebrates for food and space, and in waters of high concentrations of suspended material it encourages deposition of mud owing to the accumulation of faeces and pseudofaeces (Barnes, Coughlan & Holmes 1973).
It is considered a pest on commercial oyster beds,

competing for space and food, while depositing mud on them (Utting & Spencer 1992) and the mud rendering the substratum unsuitable for the settlement of spat (Barnes, Coughlan & Holmes 1973). In parts of Essex slipper limpets were said to far exceed oysters in abundance (Walne 1956).
Dipping infested culch and oysters in saturated solutions of brine for a short period (Hancock 1969; Franklin 1974) is the cheapest, safest and most effective method of control. For clearance of large beds, dredging and disposal above high water mark has been applied (Hancock 1969).
It has been suggested that the shells may be used as oyster culch for spatfalls in the Solent (Barnes, Coughlan & Holmes 1973).
It is thought to have been introduced to France with oysters from England. It has attained dense concentrations of up to 1750 m-2 and in some areas has been the dominant member of the macrofauna (Seaward 1987).
Photographer: Steve Trewhella

Urosalpinx cinerea

American oyster drill, American tingle, American whelk tingle
It predates native oysters; each individual consumes about 40 oyster spat (5-20 mm diameter) per year (Hancock 1954).
It devastates commercial oyster beds through predation. 'Tile traps' have been used during the summer to control this species (MAFF pers. comm.). On the Essex oyster beds at least, bounty was paid for bucket loads of U. cinerea (P. French pers. comm.).
None known.
None.

Potamopyrgus antipodarum

Jenkin's spire shell
Unknown other than it eats water cress but that is not a concern as this snail is so small.
In the early 1900s it was reported to be choking up London's fresh water supply (Castell 1962), however, the use of filters overcame this problem.
None used.
None known.
This species is known from southern Australia and Tasmania. Ponder (1988) gives evidence to support the hypothesis that it is an introduction there from New Zealand, by European man or birds (the genus has diversified in New Zealand, but there is no evidence of this in Australia). Earliest known dates for Australian introductions are: Hobart area, Tasmania - 1872; Melbourne area, Victoria - 1895; Adelaide area, South Australia - 1926; Sydney area, New South Wales - 1963. It was noted in 1889 that it was found in Tasmania "in the River Tamar and other places within the influence of salt water". In the Sydney area Potamopyrgus has bred in freshwater tanks and reservoirs and has even been distributed through water pipes to emerge from domestic taps. In South Australia it has blocked water pipes and meters. It was probably first introduced to Tasmania by way of drinking water supplies on ships and probably entered Europe at about the same time in the same way. The spread of Potamopyrgus further north into New South Wales may possibly be limited by high water temperatures, as it has been shown that New Zealand and European populations cannot tolerate a water temperature of more than about 28°C.

Crassostrea gigas

Pacific oyster, Portuguese oyster
No effects are recognised in Europe. In North America it has been known to settle in dense aggregations, excluding other intertidal species.
This species is cultivated widely as it is eaten.
None used.
Its presence benefits commercial oyster farming interests.
Crassostrea gigas and Crassostrea angulata are thought to be the same species and have been treated as such here (see e.g. Smith, Heppell & Picton in prep.). The only remaining population referred to as 'angulata' in Britain is a brood stock kept by MAFF in the Menai Strait.
Populations of adult Pacific oysters may persist for years. Crassostrea gigas from a disused oyster farm at Tighavullin, Scotland, were observed in 1993, nine years after the farm was shut down, though no young were observed (Smith 1994).

Tiostrea lutaria

New Zealand flat oyster
Unknown.
It is a commercially important edible species.
None used.
It is of potential commercial importance but is susceptible to the disease of flat oysters caused by Bonamia sp. so it is not viable to cultivate them commercially in the UK (S.D. Utting pers. comm.).

Tiostrea lutaria is thought to be conspecific with the Chilean oyster Tiostrea chilensis with the latter name possibly taking priority (Buroker et al. 1983).

Ensis americanus

American jack knife clam
Unknown.
Unknown.
None used.
It is fished in some parts of continental Europe.
In some places, e.g. Southend on Sea, Essex, in 1995 it was reported to be one of the commonest living bivalves on the shore (J. Light & I. Killeen pers. comm.).

Mercenaria mercenaria

American hard-shelled clam, little-neck clam, quahog, cherry stone clam.
It filled the niche left by the cold weather die-off of the soft-shelled clam Mya and thus prevented they re-establishment of Mya. Digging and dredging for this clam has a significant effect on the environment, particularly eel grass Zostera beds (Cox 1991; Anon. 1992). The populations of Mercenaria in the Solent are now very low (MAFF pers. comm.).
No commercial interest is known to have been adversely affected by the arrival of this species. Instead it has supported a thriving fishery from the 1960s to the present. Latterly the fishery has been severely depleted, primarily due to poor spatfall (MAFF pers. comm.), but possibly due also to the large numbers taken and physical damage to the environment.
The species is not controlled although the population has been severely depleted by the fishery.
See above.
The history of Mercenaria mercenaria in England has shown that deliberate introductions can work commercially.

Petricola pholadiformis

False angel wing, American piddock
In Belgium and The Netherlands it has almost completely replaced the native species Barnea candida (International Council for the Exploration of the Sea; 1972). In Britain, however, there is no documentary evidence for its having displaced native piddocks (J. Light & I. Killeen pers. comm.).
Unknown.
None used.
None known.
Petricola is remarkably similar to Barnea candida (an indigenous British species).

Mya arenaria

Soft-shelled clam, soft clam, long-necked clam.
Unknown.
Unknown.
None used.
In the USA this species is considered a delicacy and is used for "clam-bakes" at the beach. However, in Britain its use as a food is uncommon.
Fossils of M. arenaria dating from up to the end of the Pleiocene Epoch which ended 1.6 million years ago show it was previously native to Europe. It is thought to have become extinct during the Pleistocene Epoch, when Europe passed through a series of ice ages (Foster 1946). It was introduced either by the Vikings or during the 16th or 17th century and has become reestablished.

Chordata Styela clava

Leathery sea squirt
Serious competition for food between individuals and with other species can result if the population becomes big enough.
It is a fouling pest on ships' hulls and oyster beds.
Biological control through the deliberate introduction of Carcinus maenas into cages surrounding the sea squirt has proved to be an unsuccessful control agent. Various combinations of salinity, temperature and exposure to air have proved successful in killing Styela clava without causing the host oysters any mortality.
None are known, though it harbours many epibionts so may aid localised increases in biodiversity.
In Lancashire this species was first found in a man-made pool at Morecambe from where it spread to other high-level pools, under boulders and stones and down the shore (Coughlan 1985).

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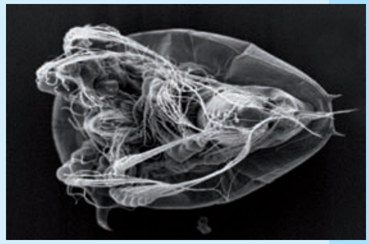
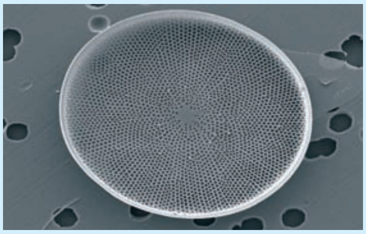







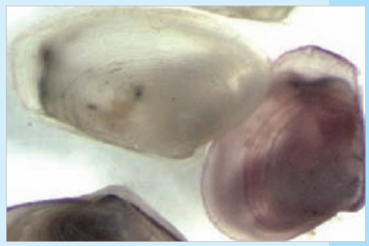

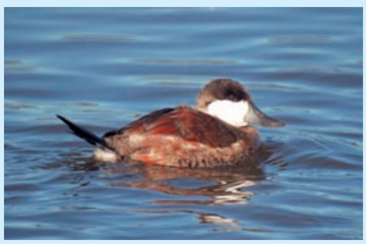
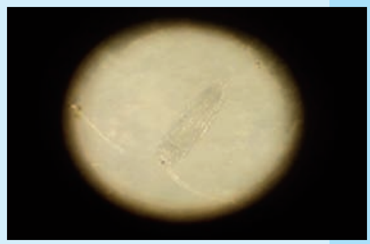





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