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# ECSA Bulletin

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Photo: J-P. Ducrotoy

Camel estuary, England

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Photo: J-P Ducrotoy

ecological model approaches: a) an end-to-end food web dynamic model, which describe both direct and indirect effects on clam in a 0D representation; b) a spatially resolved habitat suitability model and c) a 3d integrated dynamic model obtained by coupling a transport biogeochemical model to a bioenergetic and to a dynamic population models for clams. Results agree in indicating a reduction in clam suitability under A2 e B2 IPCC scenarios and points to the need of implementation of adaptive management.

### GROWTH OF THE PURPLE DYE MUREX (BOLINUS BRANDARIS) MARKED AND RELEASED IN A SEMI-INTENSIVE FISH CULTURE EARTHEN POND

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In Portugal, the purple dye murex (Bolinus brandaris) is commercially exploited by artisanal fisheries along the Algarve coast, mainly in the Ria Formosa lagoon (southern Portugal). This muricid gastropod is greatly appreciated shellfish with high commercial value in the local seafood market (reaching first sale values around 20 – 25 €/kg). Moreover, as local demand for shellfish products has augmented and the commercial value of B. brandaris has increased markedly in recent years, this species generates expectations as potential candidate for molluscan aquaculture. In this context, this study reports the growth rate of B. brandaris, estimated through mark-recapture experiments in a semi-intensive fish culture earthen pond of the IPIMAR's Aquaculture Research Station. A total of 1067 specimens (shell length = 43.38 ± 8.06 mm, range = 14.55 – 78.39 mm) were marked with Dymo® tape tags (fixed with cyanoacrylate glue and covered with epoxy glue). Marked specimens were recaptured using a traditional fishing gear locally designated as "wallet-line" and by scuba diving. After a period at liberty (interval between marking and recapture) that varied between two months and slightly over two years, 288 individuals were recaptured (shell length = 67.37 ± 6.23 mm, range = 45.29 – 88.56 mm), corresponding to a recapture rate of 27.0%. At recapture, only one specimen had lost the tag and all the remaining tags were intact and legible. Mean growth rates obtained were 0.9 ± 1.0 mm in shell length / month and 0.7 ± 0.7 g in total weight / month. On average, individuals deposited 2.3 ± 3.2 shell bands along the body whorl per year. Growth rates presented high inter-individual variability and an expected decreasing trend with shell length at marking. This study provides baseline data for the management of the purple dye murex fishery and useful information to assess the potential of B. brandaris as a new species for molluscan aquaculture.

### FACTORS INFLUENCING TREMATODE PARASITE BURDENS IN MUSSELS (MYTILUS SPP) FROM THE NORTH ATLANTIC OCEAN ACROSS TO THE NORTH PACIFIC

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[6]Laboratory of Parasitology of the Institute of the Biological Problems of the North, Magadan, Russia

The level and incidence of infection of blue mussels (*Mytilus* spp) by the trematode parasites *Himasthla, Renicola* and Gymnophallus was studied at 22 sites from north Atlantic waters (Ireland, Iceland, Norway) and across the Arctic Ocean to the Sea of Ohktosk in the north Pacific. Only at one site (Pechora Sea) were no parasites at all recorded. Infestation levels ranged up to 100% of individuals sampled.

Data were analysed with the PRIMER-E package BEST routine. A number of factors were tested as explanatory variables for the parasite frequencies, (singly and in combination) namely:

- Geographical location
- Bird predators of mussels
- Other mollusk secondary hosts
- Habitat, temperature and salinity
- Mussel population characteristics

Parasite frequencies were square root transformed and normalized, while the environmental factors were first standardised (to correct for the different scales of measurement) and then transformed.

The analysis indicated a considerable influence of geographic location, with closely-connected sites also grouped together on the basis of their parasite communities. The BEST routine suggested that the major influence on infestation was bird (primary host) numbers, but that exposure was also a strong factor. The implications of these findings in relation to human exploitation of mussels and to climate change are discussed.

### ALGARISK – THE PREDICTION OF COASTAL ALGAL BLOOMS

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Nuisance and Harmful Algal Blooms can have serious environmental and economic impact on Coastal Communities. Dense algal blooms and scums are aesthetically unpleasing in recreational waters and may cause irritation to bathers, whilst the release of algal toxins and the potential for local anoxia can impact on the viability of commercial shellfish beds. Palliative action is possible, but algal blooms are typically impacting on an area before they are detected and any management intervention is reactive. This paper will describe work undertaken by a consortium of UK regulatory and research organisations to provide a robust technique for forecasting the arrival at the coast of significant algal blooms.

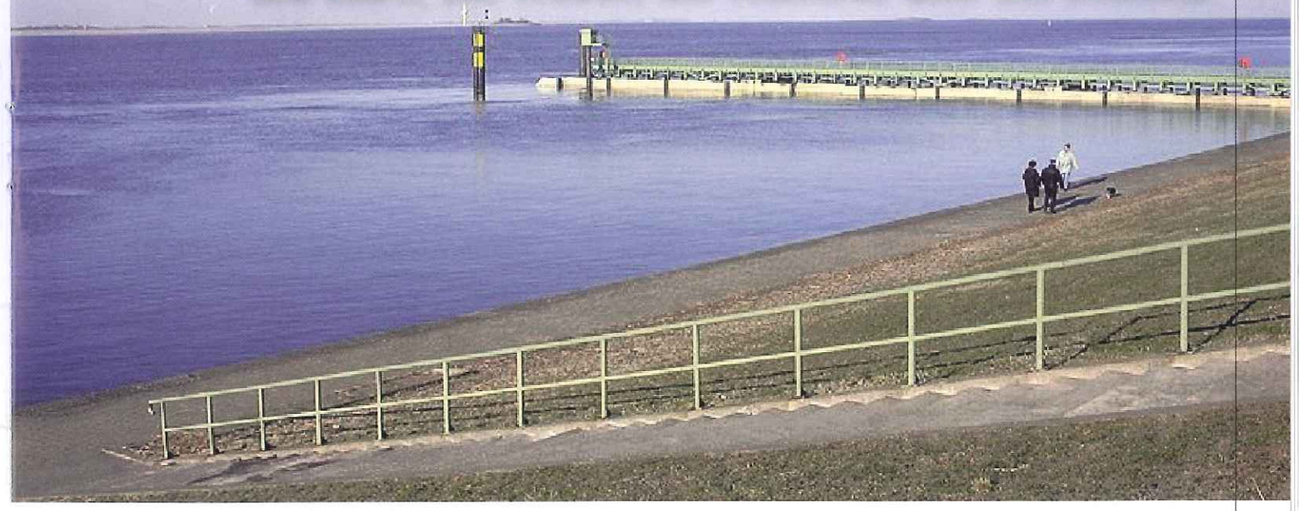
Satellite images are processed in real time to detect the onset of algal blooms offshore; these are coupled to models run daily which predict the development and propagation of the blooms for up to 5 days ahead. The final step is a simple decision support tool which assesses the risk to any length of coastline of interest. The technique has proved successful in predicting blooms at the coast which allows time for warnings and intervention. The upstream processing of satellite images and the running of the coastal models is already being undertaken routinely for other purposes so the cost of providing the warning service is relatively low. The potential for introducing a routine national service, initially for England and Wales, is now under consideration.





# Management plans for four North Sea estuaries:

## the Elbe, the Weser, the Humber and the Scheldt



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WE THINK THAT there is only one big challenge in marine and estuarine management – to maintain and protect the ecological functions while at the same time delivering the expected economic goods and services. The ports in estuaries are a good example of this – in particular, their need to profitably operate harbour facilities while at the same time ensure that they do not fall foul of legislation aimed at protecting the natural features of the areas.

In the framework of the European INTERREG IV B North Sea Region Programme, the TIDE (Tidal River Development) Project was launched in early 2010. It was officially started in February 2010 with a Kick-Off Conference in Antwerp. The work plan focuses on estuaries which are characterised by a significant tidal range and strong tidal currents accompanied by large sediment transportation rates. The aims of TIDE are to identify knowledge gaps in hydrology, morphology and ecology (in particular on estuarine functioning and estuarine ecosystem services), and integrate planning in local policy while ensuring that the EU NATURA 2000 and Water Framework Directive requirements are met.

Focusing on North Sea Region estuaries under a strong tidal influence, protected by European directives and serving as fairways to important seaports, TIDE has gathered some of the leading European experts from universities, port authorities, waterways administrations and others, to find multi-beneficial solutions for future sustainable estuary development.

With the assistance of regional working groups, state-of-the-art governance solutions will be identified and transferred to other European estuaries through conferences, workshops, lectures, TIDE on-the-road events and information materials.

## Presentation of the TIDE estuaries

In order to understand what actions are needed to restore disabled ecological functions in an estuary, the watershed and coast need to be considered as a continuum through the estuary. This kind of approach has been adopted in several macrotidal estuaries of the North in Europe: TIDE focuses on the estuaries of the Elbe and the Weser in Germany, the Scheldt in Belgium and the Netherlands, the Humber in England. These estuaries are presented here and compared in their management because they have common features which are of interest to scientists and decision-makers. They were all partially filled by marine sediments because of the Flandrian marine transgression which started about 3000 years ago. As a result plugging has occurred, with sedimentation prograding seawards. Flood plains, as part of the estuarine complex, have been claimed by humans and changed into terrestrial habitats, notably since the beginning of the 20th century. With increasing


Elbe estuary, Germany


Humber estuary, England

industrialisation and the development of shipping activities, the trend has accelerated resulting in considerable loss of intertidal areas and drastic changes in the local geomorphology (Ducrotoy, 2010). All show the following similar characteristics:

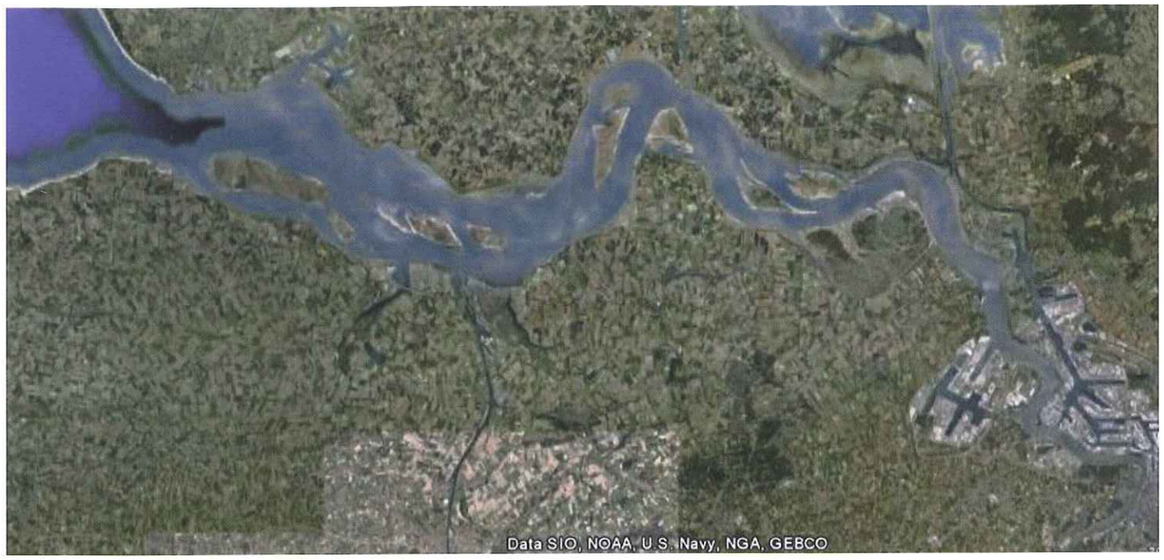
- they are used as shipping channels leading to large ports;
- they are characterised by a strong tidal influence which is accompanied by sediment transport;
- most of the estuarine areas are designated NATURA 2000 sites.

Most notably, the restoration of damaged habitats and of ecological functions in each estuary has benefited from quite different managerial approaches.

All of the selected estuaries belong to the North Sea in north-west Europe. Geographically, the North Sea was defined by the North Sea Task Force as including the English Channel, the Scandinavian straits (the Skagerrak and the Kattegat) and the northern North Sea south of 62° N (NSTF, 1994; Ducrotoy & Elliott 2008). The North Sea is a large epi-continental sea (750,000 km2) of the north-east Atlantic. It is one of the few major marine ecosystems to have been formed by the recent flooding of a landmass which took place 20,000 years ago. From a bio-geographical point of view, it is therefore a rather young ecosystem (Ducrotoy, 1995; Ducrotoy et al., 2000). It consists of a shallow (mean-depth of 90 m) semi-enclosed coastal marine ecosystem. The Southern Bight, where the selected estuaries are located, is relatively shallow, with strong tidal








Scheldt estuary, Belgium


Weser estuary, Germany

currents; the depth increases progressively towards the North where the basin largely opens to the Atlantic Ocean.

## TIDE challenges

Coastal ecosystems, estuaries especially, are among the most ecologically and socio-economically important environments. Coastal environments have huge socio-economic value through food production, nutrient and pollutants recycling, recreation and transportation (Crossland et al., 2005). Coastal ecosystems such as estuaries are naturally subjected to a variety of anthropogenic stressors which can damage the health and fitness of the resident organisms. We can regard the stressors affecting estuaries and coasts as 'local/regional managed pressures' and 'exogenic unmanaged pressures'. Multiple stressors including pollutants, excess of nutrients (e.g. eutrophication), altered habitat and hydrological regimes as well as floods and droughts can impact resources through single, cumulative or synergistic processes, lowering the overall system stability and resilience (Vinebrooke *et al.* [date?]).

Due to anthropogenic disturbances which affect those, leading to habitat modification and changes in ecosystem function, these ecosystems, together with goods and services they provide, are threatened. Sediment transport is steadily increasing and in order to keep the ports operating more and more maintenance

Photo: J-P. Ducrotoy

Scheldt estuary, Belgium.

dredging and improved sediment management is necessary. Estuarine ecosystem functions are endangered and important ecosystem services – such as flood regulation and coastal protection, water purification, habitats for plants and animals are threatened.

The exogenic unmanaged pressures include climate change – i.e. local management does not manage or control the main stressors but is designed merely to respond to the consequences. Due to climate change environmental problems will in future even get worse - unless compensation measures and appropriate mitigation concepts are found. Such changes (e.g. temperature rise, sea-level rise, increased risks of floods…) may increase the risk of abrupt and non-linear changes in many ecosystems, which would affect their composition, function, biodiversity and productivity. When subjected to climate change, including changes in the frequency of extreme events, ecosystems may be disrupted as a consequence of differences in response times of species (IPCC, 2007).

Decision-makers are faced with an increasingly challenging legal and global economic framework, for example the EU Directives such as the Birds and Habitats or Water Framework Directives need to be properly implemented. In order to maintain their competitive position and thus ensure the economic prosperity of the region despite the current crisis, the big ports need to be further developed.

## Building on existing knowledge

Former international projects and other initiatives such as HARBASINS, SedNet, New!Delta have sought to increase the knowledge on the interrelation between changes and processes taking place and tried to find possible solutions (e.g. optimised sediment management strategies; revitalisation schemes of side river arms, etc.). At the same time, development and management plans have been or are being prepared in compliance to various EU directives and/or driven by urgent issues (such as flood prevention, sediment increase, etc.). Investments in the scale of hundreds of millions of Euros are realised or in the planning process in all those estuaries. Building on this experience, TIDE aims at new, integrated solutions that many stakeholders in all of these estuaries have been looking for in recent years.

## TIDE specificities

TIDE will ensure a more integrated and effective planning of these multiple processes and promote large scale efforts in the four estuaries by taking into account the ecological, economical and

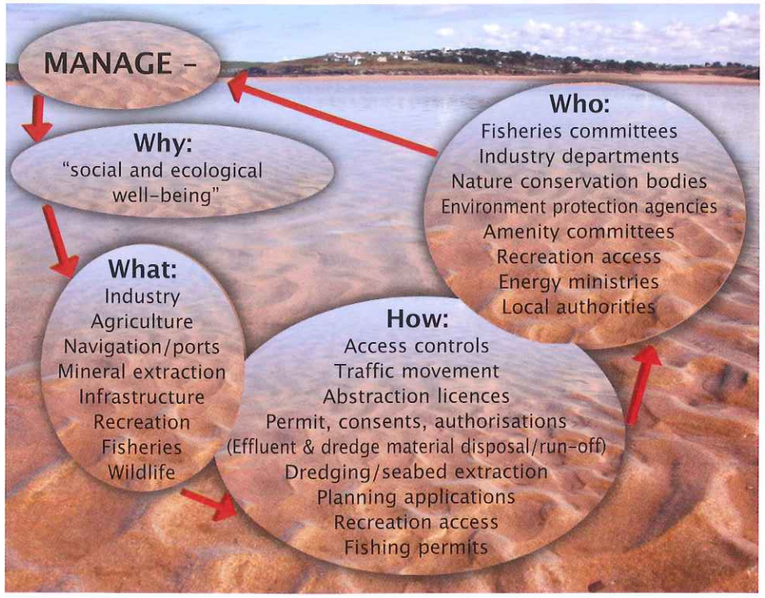



**Figure 1.** An environmental management framework





Photo: J-P. Ducrotoy

Elbe estuary, Germany.

societal needs of these regions. We emphasise here that the management of any entity relies on defining an outcome and having tools to get to that outcome. In the case of environmental management this relates to setting objectives (as the desired outcome) and making these quantitative - what may be called indicators against which monitoring can be carried out ***(Fig. 1)***. It is an axiom of management that 'you cannot manage something unless you can measure it'. The monitoring of change then needs to be carried out against a set of predefined actions – i.e. at the outset there is the need to define what managers will do if change is detected. The TIDE project will involve the use of Environmental Integrative Indicators (Aubry & Elliott 2006) which aim to bring together the hydromorphological features of estuaries, the anthropogenic pressures within systems and the environmental consequences of those pressures.

## TIDE project activities

### Science

The TIDE project will use the best available science to measure the natural and social features and to determine the capacity of the estuaries to support both ecological and economic features. 'Joined-up Environmental Thinking' is the technique to be used – this requires: Ecological Integration (habitat integrity, fit-for-purpose), User/Use Integration (and a move from a sectoral approach), Management Integration (across the prevailing legal and administrative aspects such as WFD / HSD / IMO(PSSA) / OSPAR(Annex V) / BAP / WBD / ICES / ICZM / MSFD), Monitoring Integration (with a joint programmes for cost-effectiveness), Environmental Integration (from site-based to wider study as sites are influencing and being influenced by events remote from the site) and Scientific Integration (responses to multiple stressors at several levels of biological organisation).

In doing so, TIDE will improve our knowledge about estuary functioning. Restoring functions at ecosystem level will undoubtedly help guarantee assets to human societies which depend on them. Ensuring resilience and adaptability will allow adjusting goods and services both to new environmental conditions and to emerging human needs. The resilience quantification method will for the first time allow inter-estuarine comparisons and this knowledge will reduce the risk of one-issue actions caused by limited perspectives or isolated concerns.

### Governance

Above all, estuaries within Europe are managed to protect the features designated under EU directives, for example their habitats and species and their conservation objectives. This approach is no different from that adopted in other countries, for example the US Clean Water Act. Hence we need to build these into an iterative environmental management system ***(Fig. 2)*** which treats the environment as an entity to be managed as a whole.

TIDE will use the knowledge generated to improve the effectiveness of policy mechanisms and instruments in each region. Operating via regional working groups and bringing together various stakeholders will allow it to realise integrated management and governance in each region. But, over and above all of this, integrated management of estuaries will be essential in adapting to local changing conditions (e.g. sea level rise) and slowing down climate change at global level. That is, ensuring that the local pressures are managed while at the same time ensuring that the

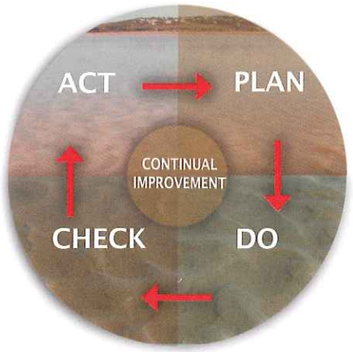



**Figure 2.** The basis of an environmental management system (from Hyde and Reeve, 2005)

consequences of external (exogenic) unmanaged pressures are also managed.

## Measures

The piecemeal application of present environmental legislation has not been sufficient to change the negative trends and integrative management plans are required at the scale of each estuary (Harris et al., 2006). All of the sites considered in this article have benefited from management schemes in order to re-establish some of the lost ecological functions: in the Elbe, the sediment dynamics, in the Scheldt, the control of floods, and in the Humber, the restoration of specified ecological processes. What is interesting is that despite the different managerial approaches applied in the various countries, all actions included some degree of ecological restoration of habitats. Such actions have involved more or less large scale engineering work. From comparing these various managerial approaches in the different estuaries, it appears that only conservation objectives can translate the aim to reduce negative developments.

TIDE will compare, assess and plan mitigation and compensation measures (i.e. sediment traps, new dredging methods, restoration of river shores). It will also jointly develop new, solution-oriented methods (esp. taking into account climate change).

## Information

TIDE will raise awareness of the issues at stake among the different target groups - ranging from EU policy makers to the general public living at estuaries. On this basis it will also improve understanding and acceptance for necessary changes. This is why, in the future, participation by local communities will be essential for the success of measures taken. Communicating with existing groups will help making visible actions taken and creating synergies with other development plans. Research and education clearly stand out as a means to achieve governance (Folke *et al.* 2005).

## Transnational

This project includes the need to use the best natural and social sciences for the management of our estuaries and tidal rivers especially as we manage to protect critical processes, to protect critical areas and species and for the production of ecological and economic goods and services. Of course, private companies also manage to prevent prosecution and to look after shareholders (and we have to remember that some port authorities in Europe are private companies while others are state bodies). We have to manage many activities but we have many tools for doing this and many public bodies to carry out that management ***(Fig. 3).***

TIDE is based on best available knowledge and practices from within the TIDE regions as well as beyond. This is ensured through jointly agreed work plans and methodologies resulting from continuous exchange of experience and knowledge among the TIDE partners and international contacts.

## Documentation

The experience gathered during TIDE will be synthesized in a joint TIDE toolbox in which assessment tools linked to governance, as the policies, laws and administrative bodies, and measuring resilience, as the ability of the estuaries to withstand anthropogenic stressors, will

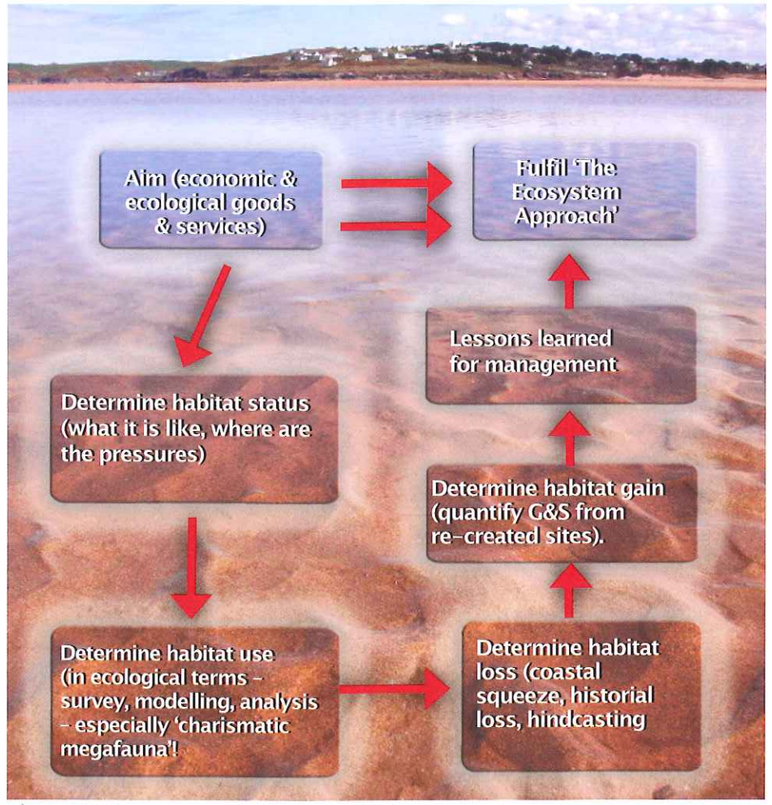



**Figure 3.** The basis of estuarine management (from McLusky & Elliott 2004)





Photo: J-P. Ducrotoy

Construction of a polder under controlled reduced tide (CRT) in the Scheldt estuary, Belgium.

be linked to an integrated estuarine management planning measure box showing the results of various measures. The TIDE toolbox will be presented to other planners, managers and decision-makers of other estuaries and related ecosystems in 'TIDE on Tour' seminars.

## Experience transfer

In order to define strategies compatible with conservation and sustainable development at the local, regional and European levels, the environmental aspects must be integrated into the management of estuaries, which must rely on a thorough collaboration between and mutual understanding of all actors and stakeholders. Resting on a rigorous scientific approach, restoring ecological functionalities in an estuary is dependent on procedures of socio-ecological evaluation including a methodology to assess the ecological quality of systems considered (Bingham et al. 1995; Costanza et al. 1998; de Groot et al. 2002).

Hence in order to get sustainable and successful management we need to harmonise within and between sectors, stakeholders, regulators, mediums, estuaries, regions, countries, outcomes and implementation. This is because the Humber, Elbe, Weser and Scheldt are regarded as multi-user spaces and so there are many things that we need to manage in the estuaries and tidal rivers (and by whom):

- habitats (nature conservation agencies),
- environmental quality (Environmental Protection Agency-type organisations),
- water space usage (port authorities),
- navigation (port authorities),
- infrastructure (municipalities/federal state),
- energy extraction (private companies),
- biological extractions (fisheries bodies),
- estuarine water extraction (private energy companies),
- upstream water abstraction (water supply companies),
- land space usage (municipalities/federal state),
- erosion and flooding control (EPA, municipalities etc),
- industry (EPA and private companies)
- and recreation and tourism (agencies).

## In a nutshell

In returning to our single, central question, we have to ask how can we maintain and protect ecological goods and services while at the same time delivering economic goods and services? As a subtext here we could ask 'how does a port stay within its environmental responsibilities and yet still be a viable business?' Hence, in brief, for each of the estuaries TIDE aims to:

- define and measure ecological functions leading to goods and services
- define and measure the economic goods and services
- indicate how they are protected, maintained and delivered
- identify uses and users
- determine conflicts between these
- propose management structures and plans
- create these where they don't exist
- suggest systems in estuaries for implementing these
- communicate these to stakeholders
- educate stakeholders where necessary and possible.

Photo: J-P. Ducrotoy

Sampling benthos in the Humber estuary, England.

# Seven tenets of sustainable environmental management

**Environmentally sustainable**: That the measures will ensure that the ecosystem features are safeguarded

**Technologically feasible**: That the methods and equipment for ecosystem protection are available

**Economically viable**: That a cost-benefit assessment of the environmental management indicates sustainability

**Socially desirable/ tolerable**: That the environmental management measures are as required or at least are understood by society as being required

**Legally permissible**: That there are regional, national, European or international agreements and/or statutes which will enable the management measures to be performed

**Administratively achievable**: That the statutory bodies such as governmental departments, environmental protection and conservation bodies are in place and functional to enable the successful and sustainable management

**Politically expedient:** That the management approaches and philosophies are consistent with the prevailing political climate

## TIDE - partners

TIDE brings together experts, scientists, policy-makers and managers representing the various economic, social and environmental interests in the estuaries:

**Elbe (Germany)**
Hamburg Port Authority www.hamburg-port-authority.de, www.tideelbe.de
Lower Saxony Water Management, Coastal Defence and Nature Conversation Agency (www.nlwkn.de)

**Weser (Germany)**
Lower Saxony Water Management, Coastal Defence and Nature Conversation Agency
Free Hanseatic City of Bremen (www.wuh.bremen.de)
University Bremen (www.uni-bremen.de)

**Scheldt (Belgium / Netherlands)**
Rijkswaterstaat (www.rijkswaterstaat.nl)
Flemish Authorities, Department of Mobility and Public Works (www.mow.vlaanderen.be)
Antwerp Port Authority (www.portofantwerp.be)
University of Antwerp (www.ua.ac.be/ecobe)

**Humber (United Kingdom)**
Institute of Estuarine & Coastal Studies, Hull (www.hull.ac.uk/iecs)
Environment Agency (www.environment-agency.gov.uk)

TIDE
Tidal River Development

**TIDE – lead partner**
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ESTUARINE & COASTAL SCIENCES ASSOCIATION

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# Estuarine and Coastal Sciences Association (ECSA)

The Estuarine and Coastal Sciences Association (ECSA) is a direct continuation of the Estuarine and Brackish Water Sciences Association (EBSA). The association was founded in 1971, and is the major European focus for the communication of research and scholarship in estuarine science. Membership is open to all who are interested in estuarine and coastal marine science, whether in Europe or further afield. The association holds local meetings, where work relevant to one specific estuary or coastal site is presented, and international symposia, where work applicable to a chosen theme of estuarine and coastal science is presented. Many of the symposia have been published. The association has caused to be published Handbooks of Methodology for estuarine studies, and Synopses of the British and European fauna, which are available to members at reduced rates. The association has an associated journal, ***Estuarine and Coastal Shelf Science,*** which is available at greatly reduced rates to members. The *ECSA Bulletin* is distributed to all members, free of charge, twice a year; this is supplemented by newsletters and association information and links are updated regularly on the ECSA website. The association has a small grants scheme for younger scientists.

**Further details and membership forms from:**

ECSA Membership Treasurer,
Dr Clare Scanlan,
Scottish Environment Protection Agency (SEPA),
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**or from the ECSA website:**
www.ecsa-news.org/joiningECSA.htm.