ECSA Bulletin

Bulletin of the Estuarine & Coastal Sciences Association

Forth Estuary,Scotland - Photo J-P Ducrotoy

The ECSA is an international society dedicated to the scientific study & management of estuaries and other coastal environments

www.ecsa-news.org

ISSN: 1352-4615

ECSA bulletin

Bulletin N° 65

This newsletter was edited by
Jean-Paul A Ducrotoy
Institute of Estuarine ans Coastal Studies
The University of Hull
Hull HU6 7RX, United Kingdom
T: +33 (0)322 238 047
E:jean-paul.ducrotoy@hull.ac.uk
With thanks to all contributors.

Instructions to Authors

The ECSA Bulletin is issued in JANUARY and JULY. Articles, reviews, notices of forthcoming meetings, news of personal and joint research projects, etc. are invited and should be sent to the Editor. Closing dates for submission of copy (news, articles, notices, reports, etc.) for the relevant numbers are **15 November** and **15 May**. These dates will be strictly adhered to in order to expedite publication. Articles must be submitted at least ***5 weeks before*** these dates in order to be edited and revised in time for the next issue of the Bulletin; otherwise they may appear in a subsequent issue. Authors are encouraged to consult an earlier issue of the Bulletin and adhere to the style of the publication.

Suggested word limits are as follows: obituaries (1500 words); articles (3000/4000 words); reports on meetings (2000 words); reports on ECSA grants (1000 words); reviews (1500 words); letters to the Editor (500 words); abstracts (500 words). Authors are requested to submit their work electronically as **Word for Windows** documents (no other software is to be used). Figures and photographs must be sent as separate copies in **JPEG format**. Articles in the series *"Estuaries in Focus"* should present current and planned research on a specific site which will be introduced by text and photographs. The suggested format for these articles is as follows: (1) Site characteristics, (2) current research, (3) future developments. Papers for *"Introducing institutions"* should be fully illustrated with (as a minimum) a photograph of the building and people at work in the field and in the lab. They should emphasise the expertise of the organisation and give full details with address, telephone number, e-mail, web-site, etc.

All papers and correspondence to:

Jean-Paul Ducrotoy, editor
jean-paul.ducrotoy@hull.ac.uk

Information on change of address and applications for membership should be sent to the Membership Treasurer and not to the Editor or publishers.

View from the chair

I am very pleased to be writing my first 'view from the chair' as the new ECSA president, but am very aware that I have some big shoes to fill and some considerable expectations placed upon me. Prof Geoff Millward stepped down in May 2015 at the AGM in Le Havre. Geoff made significant contributions to the Association in his time as president, including modernisation of our constitution resulting in a simpler, streamlined and more efficient council and a move to an electronic Bulletin using cost savings to increase awards and prizes for early career scientists. Geoff has also paved the way for us to improve our interface with members and the public and one of my key goals for the next year will be to improve our website and member access.

Perhaps our biggest challenge is to maintain and increase membership – this is critical for the Association as subcriptions from our individual, institutional and sponsor members enable the work we do and support our early career scientists. Yet, increasingly the economic situation means that scientists in both the public and private sector are operating under tightening financial constraints with little spare cash to pay for the membership of learned societies and professional organisations. That led me to consider why I joined ECSA back in 2004 and why I've been a member for over a decade. Like many people I joined to go to a particular conference – this one ECSA38 in Rouen, France.

I liked the interdisciplinary nature of ECSA meetings and the opportunities to network with ecologists, geomorphologists, geochemists and managers, and it's these opportunities that bring me back time and time again to our international symposia and more focused local meetings. More recently, I've found myself networking with other ECSA members (you know who you are!) via our Twitter feed (@ECSAssocation). I know it's not everyone's cup of tea, but is an effective and immediate way to share research ideas, new policy developments, coastal news and information on jobs and positions across our international membership.

This international collaboration and exchanges of ideas has never been more important and I've been watching news from COP21 in Paris with a particular interest in the impacts of climate change on our coasts, estuaries and oceans. As coastal and estuarine scientists we don't need to be told the significant impact that climate change will have; increased risk of coastal flooding, sea level rise, increasing sea surface temperatures, changing phytoplankton communities and increased risk to fish stocks. However, COP21 is widely thought of as the last opportunity for an international agreement in *how* to deal with climate change and we have an important role to inform and engage the public and policy makers in coastal and estuarine matters. Indeed, understanding how human-induced global climate and regional environmental change modifies the structures and functions of coastal systems is a key theme of our 56th international symposium in Bremen September 2016.

Finally, in my new role as President I would like to express thanks on the behalf of all ECSA council and members to Dr Nev Jones who stepped down from his role of trustee earlier this year. Nev has been involved in ECSA since its very early days and has taken many roles on council, including secretary, before becoming one of trustess. We are very grateful for his long-term support and hard work for the Association. One of the greatest pleasures of my presidency so far has been to present Dr Donald McLusky with a lifetime achievement award for his work on estuarine ecology and ecosystems (see later in this issue for his insightful thoughts on what constitutes an estuary). It was Donald's early pioneering work that led to our current definitions of an estuary and provided a management and scientific framework for EU legislation and conservation.

Kate Spencer
Queen Mary University of London

Membership Report

2015 has been a busy year for membership. ECSA currently has members in over thirty countries, from Sweden to South Africa and Germany to Japan. I'm pleased to say that we have increasing numbers of student members.

ECSA has many long-term members, whose continued commitment is greatly valued, but the association also needs new and young members to take us forward. ECSA Council is always keen to hear from members old and new as to what you want from the association in order to keep it relevant to its members.

One way to do this is to keep developing the ECSA website to provide more information for members and to make it easier to pay membership subscriptions. We also aim to create a specific members' section.

Newsletters are emailed out every few months, and all members are welcome to advertise courses, studentships and other information of interest to members. Please send any items to Anita Franco a.franco@hull.ac.uk.

The ECSA Bulletin has finally gone electronic. While some of us really like a hard copy, the cost of producing and posting these has increased substantially over time. In order to achieve some of the aims of ECSA, Council decided that the money saved from sending out a hard copy could be used for other worthwhile purposes such as supporting young members to attend conferences. This will become available on the website in due course, but until then it is being emailed out. If accessing the Bulletin online is a problem for you, please contact the Bulletin Editor, Jean-Paul Ducrotoy, at j-p.duc@wanadoo.fr or me at clare.scanlan@sepa.org.uk.

PLEASE remember to keep your contact details up to date by contacting me at clare.scanlan@sepa.org.uk. **If I don't have an up to date email address for you, you will not receive the newsletters and Bulletins.**

The new membership year starts on 1st April 2016, so do please remember to renew your subscription for then. If you have a standing order, please remember to check that it is for the correct, current membership rate. In fairness to members who pay the correct rate, under-payers will be given a period of grace but then removed from the membership list.

Best wishes to you all for 2016.

Clare Scanlan
ECSA Membership Secretary

Estuaries in Focus

THE FORTH ESTUARY – 40 YEARS OF CHANGE (1970 – 2010)

Donald S. McLusky
University of Stirling, Scotland

INTRODUCTION

In a recent article in the *Forth Naturalist and Historian*, Dobson (2013) has described the water quality of the Forth estuary and the extent to which it has improved over recent years. The present article attempts to review the published work on the Forth estuary over the period 1970 to the present day. This period has seen a remarkable transformation of the Forth estuary. By the mid-20th century uncontrolled disposal of domestic and industrial waste to the Forth estuary had led to a serious degradation of water quality in the estuary, most notably with periods of total anoxia in the upper estuary (Alloa – Stirling) and of severe industrial contamination in the middle estuary (around Grangemouth).

The transformation of the estuary reflects on the work undertaken by the Forth River Purification Board (FRPB) and its successor the Scottish Environment Protection Agency (SEPA). The biology of the estuary and other aspects has at the same time been extensively studied by staff and students of Stirling University, Heriot-Watt University and other organisations. Much of the published work on the estuary appeared in two publications which appeared after major symposia on the estuary. These appeared as *Proceedings of the Royal Society of Edinburgh*, Volume 93B, pages 235 – 571, 1987 and as *Coastal Zone Topics,* Volume 3, pages 1-205, 1997 both of which were edited by the present author as McLusky (1987, 1997).

In both of these publications, as well as the relevant legislation, the Forth estuary is defined as being from the tidal limit at Stirling, down to the Queensferry bridges (Figure 1). This definition of the estuary was upheld in a legal case involving the Clyde estuary (Western Ferries v. HMRC, 2011). Although this case concerned another estuary the conclusions of the court provided a legal definition for any estuary in the UK, which is equally relevant to the Forth estuary. The definition of an estuary is based on the salinity gradient, namely that:
An estuary is a semi-enclosed coastal body of water, which has a free connection to the open sea, and within which sea water is measurably diluted with fresh water derived from land drainage.

An alternative definition is that: An estuary is an inlet of the sea reaching into a river valley as far as the upper limit of tidal rise, usually divisible into three sections: a) a marine or lower estuary, in free connection with the open sea, b) a middle estuary subjected to strong salt and freshwater mixing, and c) an upper estuary characterised by freshwater but subject to strong tidal action. These definitions are also reflected in the E.U. Water Framework Directive which designates so-called 'transitional waters' and which have been taken into Scottish legislation as the Water Environment and Water Quality (Scotland) Act. These acts also define the limits of the estuary, with the lower estuary being Queensferry – Boness, the middle estuary as Boness – Kincardine Bridge, and the upper estuary as Kincardine Bridge –Stirling (Dobson, 2013).
It is quite erroneous to refer to waters seaward or east of the Queensferry Bridges as being part of the estuary – these waters are usually referred to as the Firth of Forth, notwithstanding that the legal case mentioned above ruled that the term Firth is ill-defined. The waters east of the Queensferry Bridges are fully saline or marine, are part of the North Sea, and are clearly out with any legal or scientific definition of the estuary.

The waters above Craigforth at Stirling are correctly referred to as the Rivers Forth and Teith, being freshwaters not subject to tidal movement. The term River Forth does appear on some maps for the Forth as far as Kincardine Bridge or even below – this is debatable in both scientific and legal terms, although the term Estuary of the River Forth could be considered appropriate. The present paper sticks to the well-established legal and scientific definitions of the Forth estuary as being from Stirling to Queensferry.

When referring to the salinity of the estuary it should be noted that this paper uses the practical salinity scale, using what are called Practical Salinity Units (PSU). Salinity is a scale and is thus a dimensionless unit (like pH). In older publications salinity was often expressed as parts per thousand (often abbreviated to ppt, ‰ or g kg^{-1}) being the total concentration of salts in grams contained in 1 kg of seawater. For the past 30 years salinity has been defined solely in terms of electrical conductivity. Electrical conductivity units are unfamiliar to some scientists, and have therefore been converted into the practical salinity scale. It is correct to say that 'the salinity of seawater is 34', but incorrect to say 34 PSU, ppt, ‰ or g kg^{-1} (McLusky and Elliott, 2004).

Estuaries in Focus *continued*

PRE-1970

The environmental history of the impact of pollution on the estuary and Firth of Forth is very well described in Chapter 7 of Smout and Stewart (2012). Inevitably their detailed account of the decline of the Forth since the mid-1700s is focussed on the problems created by growth of Edinburgh. The estuary's problems of pollution have always been quite distinct from those of the Firth of Forth, and centre on two regions. Firstly, the upper estuary (Stirling to Alloa) has suffered from chronic anoxia (lack of oxygen) due to organic wastes accumulating in the area, and secondly, the middle estuary has suffered from industrial waste mostly associated with the development of the port and industries of Grangemouth and its hinterland. The lower estuary has throughout history been much less affected, with the only major impact being the development of the port of Rosyth.

In all estuaries, even the most pristine ones, the upper estuary is a potential area of stress. It is in the upper estuary that the downstream currents from the river meet the upstream tidal currents flooding in from the sea. This area is known as the Freshwater- Seawater- Interface or FSI (McLusky and Elliott, 2004). As the river and tidal currents enter an estuary they begin to slow. As currents slow the coarser sediments (sand and gravel) being transported are deposited first, whilst the finer sediments (silt, muds and clay) remain in suspension. It is normal for a river to have gravels and sands on their bed, and for open sea-shores to be sandy or rocky, but for estuaries to be dominated by muddy sediments. Within estuaries the finest muds are to be found at the FSI, and indeed the finest materials often remain in suspension, creating a turbidity maximum in the upper estuary. These fine materials include both organic as well as inorganic particles. As the fine organic particles decompose they consume the oxygen in the water, creating an oxygen sag. Since the oxygen capacity of water is affected by temperature, and warm waters contain less oxygen than cold waters, this oxygen sag is always more pronounced in summer periods.

The upper estuary of the Forth is thus a natural area for deposition, for the turbidity maximum and for an oxygen sag. These natural processes have been exacerbated by mankind, who have used the estuary as a dumping ground for many years, but especially since 250 years ago. In 1766 the laird of Blair Drummond, Lord Kames, embarked on a major scheme to drain the Carse of Stirling. This involved recruiting tenants who were offered rent-free land in return for their work in removing the over-lying peat bog. The 12 foot (4 metre) deep peat was cut and placed into a mill lade, and at the Mill of Torr (near the present-day Safari Park) deposited into River Teith. The Mill of Torr operated for 61 years, from 1779 until 1840, by which time it had assisted in the removal of 20 million cubic yards of peat, moss and other vegetation. The peat and moss were carried down to Forth estuary and deposited there by natural processes. This deposition was so ruinous that the oyster gatherers and other fishermen of the estuary found their livelihoods ruined, and took the matter to court (Cadell, 1913). They succeeded in preventing further extensions of this work, such as the proposed drainage of Flanders Moss, by a court order of 1865. By this time however the peat and moss had silted up the Forth estuary from Stirling to Bo'ness, and effectively finished Stirling as a sea-port. The damage to the estuary had thus largely been done by the time of the 1865 prohibition. Since that date the towns of Stirling and Alloa have grown in size. Stirling added its domestic waste to the estuary. Alloa added not only domestic waste but also large quantities of brewery and distillery waste and this is then carried on the flood tide upstream into the upper estuary.

Grangemouth developed as a port to serve as the eastern terminus of the Forth and Clyde Canal, and the harbour there gradually grew. When the petro-chemical industries developed, firstly refining paraffin with shale oil from the Bathgate area, and later refining imported oil for many products, and finally with North Sea Oil, Grangemouth was an obvious site with both convenient flat-land, as well as an adjacent harbour for the refinery and associated chemical works. The waste from the BP refinery and the adjacent chemical works was discharged through pipes located at the high-water mark of the Kinneil mudflats. Waste from other chemical works, such as ICI, was discharged to a submerged outfall located just off the Skinflats area. In addition contaminated water, derived from domestic wastes of the Falkirk area, plus inland industries (such as Westfield paper works, or Carron Ironworks) was discharged into the Rivers Carron and Avon and carried then to the Grangemouth area. The middle estuary was thus the recipient of considerable amounts of waste, both from the Grangemouth industries, but also from inland sources.

Pollution of the Forth got progressively worse from 1860 to 1950 and various attempts at control were ineffective. Only with the establishment of the Forth River Purification Board (FRPB) in 1951 did matters begin to improve. As Collett (1961, 1972) has described, the estuary suffered from severe pollution, especially in the upper estuary, with regular periods of anoxia in the summer months, and in the middle estuary from contamination from Grangemouth industries. In 1961, for example, the impassable barrier of oxygen-sag water above Alloa prevented the movement of fish for 18 out of 25 days sampled.

1970-1979

The FRPB began to control waste discharges into the estuary, so that by 1976 the upper estuary was only impassable for fish on 3 out of 21 days sampled. The introduction of the Control of Pollution Act in 1974 further helped the RPBs impose standards, and in 1975 the FRPB merged with the Lothians RPB to create a larger FRPB. The newly-enlarged FRPB created a Tidal Waters Division, under the leadership of W. Halcrow with a laboratory at Port Edgar, South Queensferry and with their own Research vessel, *RV Forth Ranger.*

The Tidal Waters Division of the FRPB was now able to sample the estuary and firth regularly, and they were able to study the water quality, fish, sub-tidal benthos and plankton of the estuary in a way which had never been undertaken before. At the same time the staff and students of the relatively new University of Stirling began to sample the intertidal areas of the Forth estuary. Between these two organisations a series of publication on the estuary emerged.

Most of the published papers of the 1970s refer to the fauna of the intertidal areas, with the results of the sub-tidal studies not appearing until the next decade. McLusky, et al.(1976) gave a summary of the status of the intertidal invertebrates and their bird predators for the middle and lower estuary, in particular highlighting the importance of the three large intertidal areas of Skinflats, Kinneil and Torry Bay, and indicating the impact of discharges in the Grangemouth area as well as the threat from several reclamation proposals. McLusky, Elliott and Warnes (1977) and McLusky (1979) extended the study area to include the upper estuary, showing that the impact of the oxygen sag resulted in a fauna consisting only of pollution-tolerant Oligochaete worms. Stout (1976) calculated the oxygen deficits associated with effluent inputs to the Forth estuary.

The Skinflats area was one the first areas of the estuary to be designated as a nature reserve, due to its bird populations. The Shelduck there were studied by Bryant and Leng (1976), and the waders by Bryant (1979). Warnes (1981) undertook her Ph.D. thesis on the impact of overwintering birds at Skinflats on the production of the benthic fauna. The Torry Bay area was studied, mainly for its rich mollusc fauna, by McLusky and Allan (1976) followed by the Ph.D. thesis of Elliott (1979) much of which later appeared in McLusky and Elliott (1981) and Elliott and McLusky (1985). In 1976 McLusky began an annual study of the Kinneil area on behalf of BP industries.

1980-1989

Probably the key publication of the 1980s was the Royal Society of Edinburgh's Proceedings Volume 93B in 1987 which was devoted to the estuary and Firth of Forth (McLusky, 1987). It contains 26 papers about the estuary and firth. Rather than try and summarise each paper, the titles and authors are listed in Table 1. The range of papers from geology, climate and water quality through to birds, fish and seals represents the most complete record of the Forth estuary in the 1980s. All the papers to some extent reflect on the pressures from inputs that affected the Forth, but at the same time they show that the ecosystem of the middle and lower estuary, and the adjacent firth, was functioning and productive.

In addition, many of the studies which had begun in the 1970s appeared as publications of the 1980s. McLusky (1982) gave the first detailed results of the impact of the Grangemouth refinery discharges on the Kinneil area, indicating gross or severe pollution at distances of up to 500 m from the discharges, pollution at 0.5-1.5 km distance, and moderate pollution of recovery beyond 1.5 km distance. Further data in McLusky and McCrory (1989) indicated recovery in from the effects of pollution as improvements to the discharges were implemented.

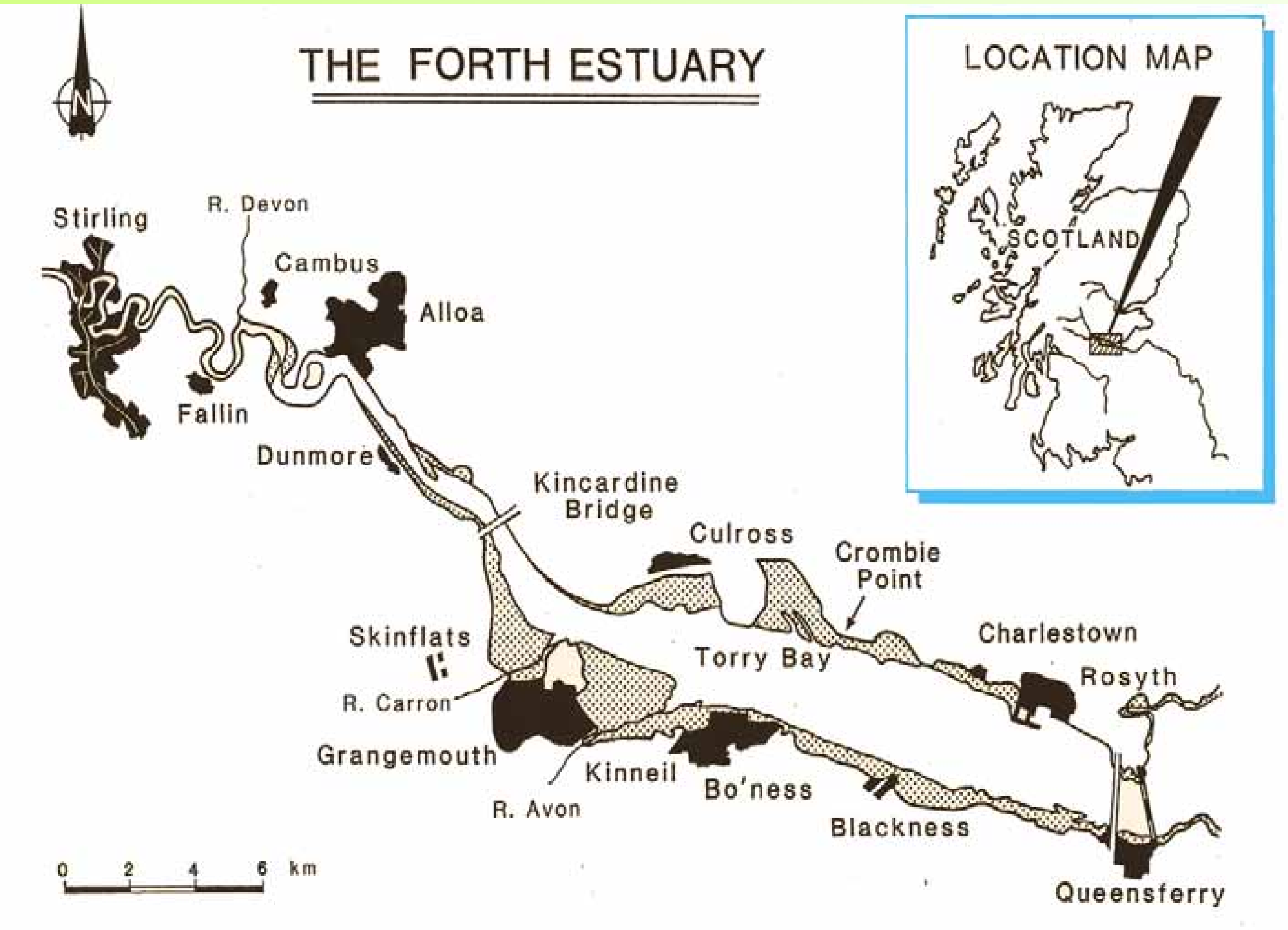
One group of animals which has dominated the fauna of the inner and middle Forth estuary are the Oligochaete worms. These worms are regarded as 'opportunistic' and tend to increase in number in polluted areas, in contrast to other groups such as polychaete worms, molluscs or crustaceans which decrease in polluted areas. The populations of oligochaetes throughout the Forth estuary from Stirling to Boness were described by McLusky, Teare and Phizacklea (1980) showing how they dominated the fauna of the upper estuary. Bagheri and McLusky (1982, 1984) studied these worms in greater detail looking especially at populations at Skinflats, Culross and Kinneil.

In the lower estuary, McLusky, Anderson and Wolfe-Murphy (1983) examined the impact of bait-digging on worm and other populations near Blackness, whilst in the upper and middle estuary McCraw (1985) studied the populations of the polychaete worms *Nereis and Nephyts.* Roddie, Leakey and Berry (1984) reported on the populations of the planktonic copepod *Eurytemora affinis* in the upper reaches of the estuary, and Berry (1989) described the *Retusa obtusa* populations at Torry Bay.

In the upper estuary, Proctor, Fraser and Thompson (1983) described the saltmarshes, noting the reduction in their extent due to reclamation, whilst Maitland et al. (1984) reported on the status of the river lamprey*, Lampetra fluviatilis;* Harrison and Phizacklea (1985, 1987) meanwhile examined the heat storage capacity of the mudflat at Skinflats.

The results from the sub-tidal studies undertaken by the FRPB appeared as Elliott and Taylor (1989a, b) and Elliott et al. (1988) examining both the sublittoral benthos and the fish communities of the estuary. Elliott and Griffiths (1986) described the levels of mercury contamination in many components of the estuary's fauna, with Clark and Topping (1989) providing further results on mercury concentration in fish. Collett and Leatherland (1985) gave an overview of the management of water pollution control in the estuary to that date.

During the 1980s the FRPB exercised its powers by requiring many local authorities to install or upgrade their sewage works, and industries to modify their processes to reduce or eliminate their discharges. Table 2 indicates the key capital works begun or completed at that time. One major change was the UK-wide implementation of the need to reduce discharges of all the most persistent toxic chemicals (Red-List substances) to the catchment of the North Sea. For the Forth estuary this meant the cessation of mercury and cadmium discharge from ICI/Zeneca in 1985.



The Forth Estuary. After McLusky (1987). The lower estuary is Queensferry – Boness, the middle estuary is Boness Kincardine, the upper estuary is Kincardine – Stirling (see Dobson, 2013).

1990-1999

More of the findings of the FRPB's Tidal waters Division's studies appeared throughout this decade. Elliott, Griffiths and Taylor (1990) showed the importance of the Forth estuary as a nursery ground for North Sea fishes. Taylor (1993) described the full range of zooplankton from freshwater sites, through the estuary to the fully marine firth. Harper, Ridgeway and Leatherland (1992) gave the concentrations of the so-called 'Red-List Substances' hexachlorobenzene and other related chemicals.

The dissolved elements of the estuary were described in a series of publications from the Aberdeen Marine Laboratory's staff and their associates. These include Balls (1992) for the nutrients, nitrate, silicate and phosphate, Laslett and Balls (1995) for dissolved Mn, Ni and Zn, Balls et al. (1994) for nutrients and trace metals over a complete tidal cycle, Balls et al. (1996) for dissolved oxygen and nitrification in the upper estuary, Lindsay et al. (1996) for the effects of tidal range and river discharge on suspended particulate matter fluxes, Owens et al.(1997) on suspended particulate matter, Lindsay et al. (1997) on a comparison between the Forth and a South African estuary. Balls, Hull, et al. (1997) looked at trace metals throughout Scottish estuaries and coasts, and Bell et al. (1997) looked at contaminated sediments of the Clyde and Forth estuaries. Balls, Owens and Muller. (1997) showed that rivers were now the main source of metals (Pb, Cu, Cd, Zn) to the Forth estuary. Lindsay et al. (1998) gave a further report on the contaminated sediments of the Forth.

The impact of land-claim (sometimes miscalled Reclamation) on the intertidal areas of the Forth estuary was calculated by McLusky, Bryant and Elliott (1992). Their original map (here Figure 2), which has been much copied, showed that almost 50 % of the intertidal area has been destroyed for a variety of purposes, including agriculture, harbours, waste and refuse disposal and industrial development. They calculated that land-claim has removed 24 % of the natural fish habitats of the estuary, and thereby removed 40 % of their food supply

Many of the major capital works initiated or begun in the 1980s came to fruition in the 1990s (Table 2). Griffiths (1997) gives a clear overview of the improving quality status of the Forth estuary, noting in particular the significant improvements in the disposal of domestic and industrial effluents made since 1985. The proportion of the estuary regarded as being of good condition increased from 32 % in 1989 to 44 % in 1994, whilst the area of poor condition area has decreased from 23 % in 1989 to 15 % in 1994, with the biggest single factor being the improvements to Quest International's yeast factory effluent produced at Menstrie but discharged at Alloa which prior to treatment contributed over 70 % of the oxygen demand load to the estuary. Miller and Dobson (1997) gave further classification of the condition of the Forth estuary on the basis of trace metals in fucoid algae.

Significant improvements to the water quality of the Skinflats area were reported by Riddle (1997) in his modelling study of the impact of the Zeneca/ICI effluent in relation to the improvements implemented since 1985. Reflecting on the changes made to mercury discharges to the estuary from this source, Mathieson undertook a detailed study of the eelpout *Zoarces viviparus* as a means of bio- monitoring for mercury. His results appeared as Mathieson et al. (1996)

Wallis and Brockie (1997) developed a water quality model for the estuary, and Dobson (1997) was able to use the model to help identify the factors influencing the dissolved oxygen budget of the estuary. She found that suspended solids consumed approximately 40 % of the total oxygen deficit in the upper estuary, whilst domestic and industrial inputs accounted for approximately 50 % of the total oxygen deficit. She predicted that the importance of particulate matter in the consumption of oxygen meant that the benefits of reducing inputs would be long-term rather than short-term. This has indeed been proved to be the case – see Dobson (2013).

The economic costs of pollution control came under scrutiny. Moffatt, Hanley and Hallett (1991) provided a framework for water management of the estuary in respect of economic incentives. Faichney et. al. (1997) were able to calculate the economic costs of the environmental improvements made to the estuary. Hanley et al, (1998) combined economic and environmental modelling of the estuary.

The intertidal fauna of the Kinneil area (in front of the refinery complex) has been studied annually since 1976, and McLusky and Martins (1998) were able to show clear increases in density, expressed either as mean number of species, or as diversity indices over a 20-year period. These increases in diversity were shown to be a clear community response to the improvements made to the petro-chemical wastes discharged to the area. In addition to the studies of the macrofauna of Kinneil, Telfer and Wilkinson (1997) measured the effect of the petrochemical effluents on transplanted *Fucus vesiculosus.*

Estuaries in Focus *continued*

The major shrimp (mostly *Crangon*) populations of the Forth estuary were studied by Jayamanne and McLusky (1997), emphasising the shrimps as a key role in the food web linking the benthic invertebrates to the fish populations. The crab populations of the estuary (five species) were fully described by Mathieson and Berry (1997). Bryant and McLusky (1997) showed how the bird predators of the Forth estuary had responded to changing food densities. At Kinneil, redshank increased in association with an increase in *Corophium volutator*, and bar-tailed godwit with polychaete worms. At Skinflats, knot and oystercatcher rose in response to *Hydrobia ulvae* and *Cardium edule* densities respectively.

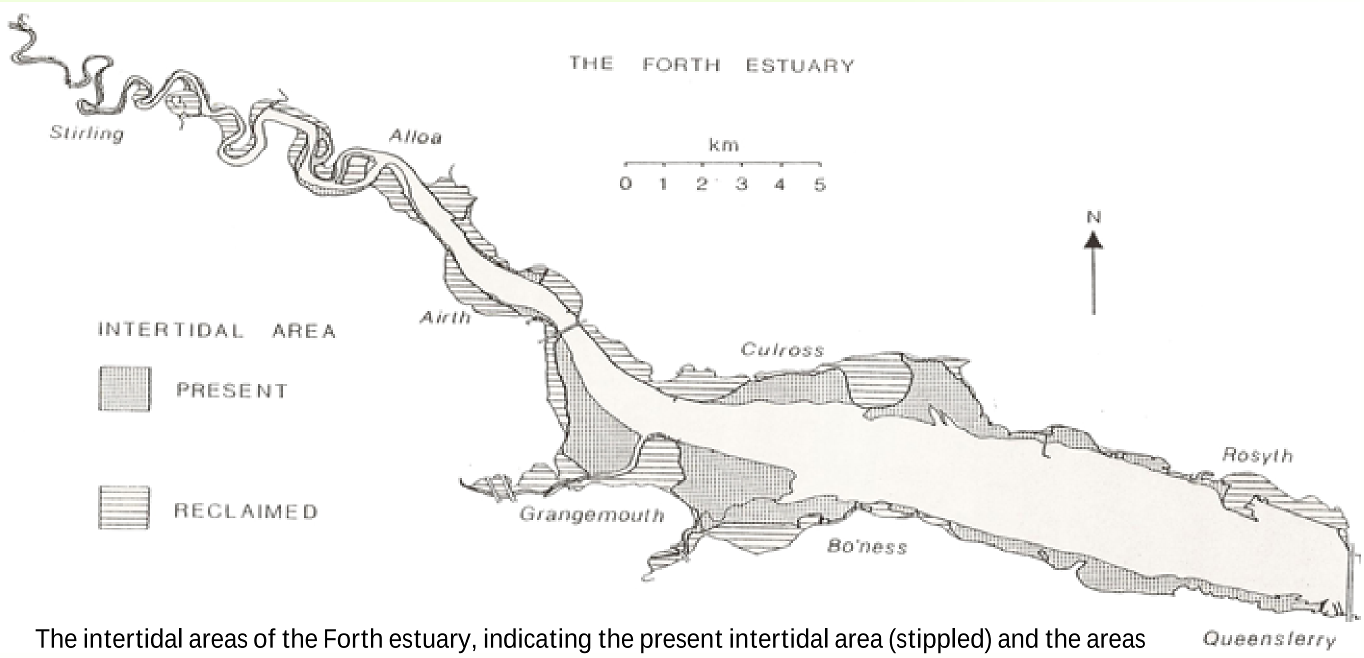
Ross and Berry (1991) examined the winkle, *Littorina saxatilis*, populations at several sites in the estuary and firth. Berry et al. 1992) examined the breeding of *Retusa in* relation to its prey *Hydrobia ulvae*, Berry (1994) looked the forminiferan prey of *Retusa* and Berry (1997) gave further details of his study of the biology of *Retusa* at Torry Bay.

The upper reaches of any estuary are a region of stress for the animals inhabiting the estuary. Typically the number of species decreases in a gradient from the seaward mouth of the estuary, and from the riverine head of the estuary (McLusky and Elliott, 2004). The minimum number of species is typically recorded at a salinity of 4. Apart from this natural decline of species the upper estuary of the Forth has suffered from 200 years of decline due to the clearance of Blair Drummond moss, followed by the domestic and industrial organic discharges from Stirling and Alloa, creating marked oxygen sag.

As a result the upper estuary was for years only inhabited by pollution- tolerant Oligochaete worms (McLusky, Hull and Elliott, 1993). As recovery began to occur it became possible to plot the reinvasion of other species. McLusky and Lassiere (1993) noted that the rag worm *Nereis diversicolor* had gradually moved up from Dunmore to Alloa and by 1993 had reached Cambus. The next species to move upstream from Kincardine to Alloa were the amphipod *Corophium volutator*, the bivalve *Macoma balthica* and the small snail *Hydrobia ulvae.* In the water column the copepod *Eurytemora affinis* inhabited the freshwater-seawater interface area, and in the fishes Herring and Sprat now regularly reached Alloa, and most dramatically the Sparling (*Osmerus eperlanus*) returned to the upper estuary after an absence of many years (Maitland, 2010).

At the head of the estuary is a rarely-studied zone – the Tidal Freshwater zone, which on the Forth is from the tidal limit at Craigforth down to between Cambuskenneth and Fallin, a distance of 9-21 km (McLusky, 1994). McLusky, Hull and Elliott (1993) reported that there were 10 species at the tidal limit (mostly insect larvae) reducing to 2 species (Oligochaetes) by 8 km (Cambuskenneth).

The FRPB which had done such sterling work in restoring the Forth estuary was incorporated (along with all the other PRBs) into the new national Scottish Environment Protection Agency (SEPA) in 1995. Whilst SEPA is now responsible for monitoring and policing the estuary it must be acknowledged that the quality of the estuary was effectively turned around by its predecessor, the FRPB.



The intertidal areas of the Forth estuary, indicating the present intertidal area (stippled) and the areas of the intertidal which have been subject to land-claim (or reclamation) (horizontal lines. After McLusky, Bryant and Elliott (1992)

2000-2010

The Urban Waste Water Treatment Directive of the 1990s was followed in 2000 by the Water Framework Directive (WFD) and widened the focus of environmental legislation from protecting water quality to encompass the protection of wildlife (Dobson, 2013). Unlike previous legislation the WFD takes account of the impact on wildlife of the physical modification of the estuary in addition to water quality.

By the year 2000 the quality of the Forth estuary had so improved that authors were able to review the considerable progress made. Dobson, Edwards, Hill and Park (2001) reviewed a variety of criteria, especially noting the increase in water quality, as dissolved oxygen, in the upper estuary. Dobson (2000) was now able to report on long-term trends in trace metals in biota in the estuary from 1981-1999, confirming a steady decline. Davis (2001) was able to analyse the considerable improvements that had occurred at the Kinneil area, as the petro-chemical effluents there had been either removed or controlled. Greenwood, Hill and McLusky (2001) reported on the fish populations, showing no trend in species richness from 1982-2001, but a reduction in total abundance, largely due to reductions in whiting and eelpout.

Greenwood also studied the fish mortality by impingement at Longannet Power Station (Greenwood, 2008a) and compared the cooling-water intakes versus trawls as estuarine fish sampling tools (Greenwood, 2008b). He found large quantities of herring and sprat and small individuals of all species collected at the cooling-water intake which were largely omitted from trawl samples. The fish assemblages of European tidal marshes were fully described by Mathieson et al. (2000), with a comparison based on species, families and functional guilds. This study covered six European estuaries with the Forth and the Humber as the UK examples.

Whilst the chronic sources of pollution have been successfully dealt with during the period 1970-2010, so pollution from other sources may become apparent. In particular the presence of diffuse sources of pollution may become detectable. The presence of potentially carcinogenic substances in European flounder was investigated by Lyons et al. (2004) at eight UK estuaries, with the Forth populations being grouped with those estuaries showing only background levels of DNA damage. Kirby et al. (2004) reported on endocrine disruption in male flounder from several UK estuaries over the period 1996-2001, and showed a decrease in oestrogen contamination in Forth populations.

A survey of the Forth estuary in 2000 by Smith et al. (2001) identified low levels of alkyl phenols in water samples from the Forth estuary, and suggested that the concentrations determined were consistent with a contaminated though not grossly polluted estuarine system. Emerlogu et al. (2013) has given more recent information on dissolved organic contaminants in the estuary.

Turner (2000) reviewed the trace metal contamination from six UK estuaries including the Forth and Clyde, and gave an empirical evaluation of the role of hydrous iron and manganese oxides. Graham et al. (2001) looked at the importance of both natural and anthropogenic sources of organic matter in the sediments of the Forth estuary, and found consistent results throughout the estuary, with no specific anthropogenic source detected.

Augley et al. (2007) described the use of carbon stable isotopes as migration markers for nursery fish stocks, and Augley et al. (2008) evaluated the effect of salinity on juvenile plaice collected from the estuary and maintained in a laboratory experiment, with those at a salinity of 25 doing best. Barnes and Upstill-Goddard (2011) reported on the dissolved nitrous oxide and dissolved inorganic nitrogen of the estuary. Barras and Paul (2000) described the post-reclamation changes that had occurred in estuarine mudflats adjacent to the Skinflats area. Another recent studies of the estuary was Elliott and Neill (2007) on the tidal flow into the estuary at Queensferry.

The monitoring of water quality of the estuary continues (Dobson, 2013) and shows a steady recovery in all parts of the estuary. There is however still sufficient organic matter in the bed of the upper estuary to produce some depletion of oxygen particularly when the turbidity increases during the summer spring tides. The intertidal and sub-tidal benthos, especially of the middle estuary, is monitored on a bi-annual basis by SEPA and partners under the Forth Environmental Assessment Programme (FEEAP). This programme shows a continual steady improvement in all areas as they recover from centuries of damage. The lower estuary is now classified as being of good ecological status.

Estuaries in Focus *end*

This literature review of the environmental history of the Forth estuary has been able to record the many publications which have appeared since the acceptance of the very poor state that the estuary had been allowed to reach by the mid-20th century. The estuary has suffered catastrophically from the effects of mankind, firstly from 1766 onwards by the clearing of Blair Drummond moss and the deposition of vast quantities of moss and peat into the estuary. Although this was prohibited in 1865, the damage had already been done. Thereafter the expansion of the towns of Stirling and Alloa both of which discharged their sewage in to the estuary, plus the organic-rich effluents from the brewing and distillery wastes from Alloa, Cambus and Menstrie led to a serious situation in the upper estuary. Meanwhile the middle estuary suffered from the rise of industry in the Grangemouth and Falkirk area.

The formation of the FRPB in the 1950s started the reversal of two centuries of decline for the estuary, but the recovery did not really gain momentum until additional powers were granted in 1970s. Major capital works followed in the 1980s, so that by the mid-1990s and the formation of SEPA the estuary's recovery was well under way. By the year 2000 much of the recovery had been achieved or was well underway, but the process is proving to be a slow and steady process as much organic debris remains in the upper estuary. Whilst the chronic sources of pollution have been successfully dealt with during the period 1970-2010, so pollution from other sources may become apparent. In particular the presence of diffuse sources of pollution may become detectable. Diffuse sources include, for example, the oil-contaminated run-off from motorways, or the drainage of excess fertiliser nutrients from agricultural fields.

In contrast to the clear recovery of the estuary in terms of organic, domestic and industrial waste contamination, the effects of land-claim are largely permanent, and it can be seen that in a historical context that land-claim has affected the estuary more than pollution. Although some limited schemes for the reversal of land-claim have been undertaken in the Kincardine area, it must be accepted that most land-claim can never be reversed, and as a consequence the best that can ever be achieved for upper and middle parts of the estuary is Good Ecological Potential rather than Good Ecological Status. The lower estuary is now classified as being of Good Ecological Status and supports a variety of fish.

Student Report

The Aquatic Biodiversity and Ecosystems Conference – Liverpool, UK

University of Liverpool, 30th August - 4th September 2015

Aline Martinez & Rebecca Morris, University of Sydney

The Aquatic Biodiversity and Ecosystems Conference was held in Liverpool with the objective to attract marine and freshwater scientists to discuss a variety of subjects related to the mechanisms of change in biodiversity and ecosystem functioning. This conference emerged from the idea of revisiting some themes of the Plant-animal interaction meeting that was held 25 years ago in Liverpool. Instead of limiting the conference to this topic, the organisers decided to expand the discussion to other subjects relevant to ecology in all aquatic systems. The broad themes of the conference included topics on fundamental ecology (evolutionary biology, dispersal and connectivity, and food webs), applied ecology (management, fisheries and conservation) and climate change. The meeting aggregated researchers from 140 institutes representing more than 40 countries.

This conference was a great opportunity to meet worldwide leading researchers on plant-animal interactions, which is the subject of Aline Martinez's PhD. Aline is investigating interactions among herbivores and the consequent effect on algal assemblages on intertidal rocky shores. She is particularly studying the behaviour of herbivorous starfish, on which the ecology is still poorly understood, despite being abundant in many rocky shores. Aline presented part of her work at the conference, showing that one species of herbivorous starfish in Australia is an efficient and strong competitor, matching limpets. Aline's work is an important contribution to the advances in the field as her findings have consequences for the dynamics of rocky shores. While new findings contributed to the knowledge of plant-animal interactions, other presentations showed how many benthic communities are changing under climate change.

The changes in community structure and hence ecosystem function seemed to be a general concern in the scientific community present at the conference. Not only changes due to climate change, but also due to the expansion of human occupation on the coast and the consequent loss of natural habitats. This was the primary theme of the ECSA 55 conference, directly after Aquatic Biodiversity and Ecosystems Conference in London. Held on the heavily modified Thames Estuary, this was an ideal location to discuss the management of coastal seas and estuaries. Particularly, how to manage conflicting socioeconomic and environmental demands with climate change and increasing urbanisation. ECSA 55 attracted not only the scientific community, but also many managers and end-users of the research. This facilitated multidisciplinary discussions, which is essential for effective management of our coastlines.

In both conferences there was a large focus on the introduction of artificial structures into the coastal environment, for example seawalls, breakwaters and marinas. This gave Rebecca Morris the opportunity to present her research on managing the impact of seawalls in Sydney Harbour, Australia. Increasing research shows that artificial structures, amongst other impacts, do not support the same assemblage of species as natural habitats. Rebecca's project aims to mitigate the effects of artificial structures on natural assemblages by adding habitat features to increase the heterogeneity of the substratum for colonising organisms. The results from her study, as in others worldwide, have shown significant increases in biodiversity through simple redesign of some of the features of manmade infrastructure. The question is now, whether the new communities attracted to these habitat features function in a similar way to natural shores.

In summary, both of these conferences were a great forum for interesting discussions, concentrated on the shifts occurring in aquatic ecosystems due to increased human pressure and climate-driven changes. The outcomes of these conferences highlighted the importance of long-term studies and investigations of the mechanisms that are causing changes in community structure, in order to develop strategies of management and conservation to maintain ecosystem function. Attending the conferences gave Aline and Rebecca the invaluable opportunity to take part in discussions with a worldwide community of researchers, and we are very grateful to ECSA who helped us to be able to attend.

Introducing Institutions

The Environment Agency (EA)

The Environment Agency (EA) is a non-departmental public body, established in 1996 and sponsored by the United Kingdom government's Department for Environment, Food and Rural Affairs (DEFRA), with responsibilities relating to the protection and enhancement of the environment in England (and until 2013 also Wales).

We were created by the Environment Act 1995, and came into existence on 1st April 1996. We had responsibility for the whole of England and Wales but with specifically designated border arrangements with Scotland covering the catchment of the River Tweed.

We took over the roles and responsibilities of the National Rivers Authority (NRA), Her Majesty's Inspectorate of Pollution (HMIP) and the waste regulation authorities in England and Wales including the London Waste Regulation Authority (LWRA). All of the predecessor bodies were disbanded and the local authorities relinquished their waste regulatory role. At the same time, the Agency took responsibility for issuing flood warnings to the public, a role previously held by the police.

Environment Agency KFH :
« The Environment Agency headquarters in Peterborough, UK »

On 1 April 2013, that part of the Environment Agency covering Wales was merged into Natural Resources Wales (NRW), a separate body managing the Welsh environment and natural resources.

Currently the operational arm of the Environment Agency consists of 16 areas, all of which report to the Director of Operations. As of April 2014, the Environment Agency removed its regional level of administration (formerly Anglian Region, Midlands Region, North West Region, South East Region, South West Region and Yorkshire & North East Region) to be replaced by an "area once, national once" model. We have around 10,600 employees. Our head office is in Bristol and we have another office in London. We have offices across England, divided into our new 16 local areas.

Our remit covers the whole of England, about 13 million hectares of land, 22,000 miles (35,000 km) of river and 3,100 miles (5,000 km) of coastline seawards to the three-mile limit which includes 2 million hectares of coastal waters. In a sharing arrangement with the Scottish Environment Protection Agency (SEPA), we also exercise some of ours functions over parts of the catchments of the River Tweed and the Border Esk which are, for the most part, in Scotland.

We are the main regulator of discharges to air, water, and land – under the provisions of a series of Acts of Parliament. We do this through the issue of formal consents to discharge or, in the case of large, complex or potentially damaging industries by means of a permit. We are also principle consultee and advisor to other licensing and regulator organisations (eg the Marine Mangement Organisation, MMO).

We have a duty to maintain and improve the quality of surface waters and ground-waters and, as part of this duty we monitor the quality of rivers, lakes, the sea and groundwater on a regular basis. Much of this information is required by law under the provisions of a number of European Directives to be reported both to Parliament and to Europe and to be made public. Some of these duties have been in force through predecessor agencies and as a consequence we maintain some long term data sets.

Introducing Institutions *continued*

Within England we're responsible for: regulating major industry and waste; the treatment of contaminated land; water quality and resources; freshwater and migratory fisheries; inland river, estuary and harbour navigations; and conservation and ecology. We are also responsible for managing the risk of flooding from main rivers, reservoirs, estuaries and the sea.

Our priorities are: to work with businesses and other organisations to manage the use of resources; to increase the resilience of people, property and businesses to the risks of flooding and coastal erosion; to protect and improve water, land and biodiversity; to improve the way we work as a regulator to protect people and the environment and support sustainable growth.

Sampling in the DEE estuary

Marine Work

The Environment agency has a range of staff dedicated to various marine topics such as monitoring and surveillance; analysis and reporting, policy, legal and regulatory issues. We employ marine survey officers, ecologists, chemists, modellers and statisticians and have a number of marine vessels at our disposal.
Under the Environment Act, we monitor environmental quality out to 3 nautical miles (nm) for water quality. The Water Framework Directive (WFD) applies out to 1nm.

We work closely and collaborate with other marine organisations undertaking joint monitoring and assessment through the UK Marine Monitoring & Assessment framework. We are involved with citizen science and university schemes to make 3rd party data available as part of the wider evidence base for environmental assessment and decisions.

We undertake our marine monitoring and assessment work using the "area once, national once" model colloquially known as "the boots and boats model": local or shore based ("boot") work tends to be done by one of the local area monitoring teams, whereas offshore, subtidal, or more technically specialist work may be carried out by one of our National Services (eg Geomatics who supply aerial and bathymetric services, or ECMAS who provide the "boats").

Introducing Institutions *end*

Our Estuarine and Coastal Monitoring and Assessment Service (ECMAS) comprises two parts: the marine monitoring teams, undertaking vessel-survey work (from survey planning to reporting) for internal customers or other monitoring partners; and the marine Assessment and Reporting teams, providing advice and assessment work for various internal and external customers.

The monitoring team provide an estuarine and coastal survey and data service, amongst other things they:

Manage boat-based marine environmental monitoring for UK and European needs
Deliver sampling and data collection activities associated with the programme
Collaboratively monitor and share data with the UK's competent monitoring authorities
Manage national ecological laboratory analysis contracts
Investigate and develop new field equipment and methods for UK and EU compliant tools
Support the production of subtidal sampling guidance and risk assessments
Provide national training in subtidal sampling techniques and Health and Safety
Load national benthic invertebrate and phytoplankton dataset to our data archive.

Our marine assessment and reporting team develop tools for European directives (eg WFD) and provide interpretation and technical support to areas and other national teams in evidence collection, planning, permitting and investigations. Amongst other things they undertake:

Data analysis and reporting for UK and European commitments (e.g. Water Framework Directive)
Investigating and developing UK and EU compliant tools for assessing marine environmental quality
Assisting in the development of national plans for marine monitoring programmes

Providing advice on marine ecological impacts and evidence needs for marine developments and permits for Area and National requirements (e.g. Nuclear new builds)
Collaborating in internal research and with the UK's competent monitoring authorities and conservation agencies


The Thames Humber Guardian

Participating in the UK's evidence and quality assurance groups for the UK Marine Monitoring and Assessment Strategy and ensuring consistency of approach.

We work closely and collaboratively with other agencies such as NRW, Natural England (NE); Joint Nature Conservation Committee (JNCC); Centre for Environment Fisheries and Aquaculture Science (CEFAS), Inshore Fisheries and Conservation Associations (IFCAs), the MMO other members of the DEFRA family and European institutions.

The Solent Guardian

Announcement

Nominations for ECI and IRPE Prize Winners

Since 1986, the International Ecology Institute in Oldendorf/Luhe, Germany (Founder Prof. Dr Otto Kinne) has selected each year two top performers in the field of ecology: the winner of the Ecology Institute (ECI) Prize (which carries an endowment of €6000) and the winner of the International Recognition of Professional Excellence (IRPE) Prize (which carries an endowment of €3000).

The Prize Winners are selected by a jury consisting of 7 distinguished ecologists, chosen by the Institute's director. The prizes are awarded in annual sequence to marine, terrestrial or freshwater ecologists distinguished by outstanding and sustained scientific achievements. The Ecology Institute prize both honours the recipient and requires him or her to serve science and society by authoring a book published in the series "Excellence in Ecology" and made available worldwide on a non-profit basis.

The expectation is that the the text and figures of the book will be submitted within three years of the award of the prize. The books present the personal experiences, insights and visions of their authors. They should criticize freely, and courageously formulate new scientific concepts. EE books are often donated to libraries in developing countries.

Ecology Institute prize winners, their major achievements and their EE book titles are listed under ECI Prize Winners. International Recognition of Professional Excellence prize winners and their major achievements are listed under IRPE Prize. The aims of the International Ecology Institute are summarized at International Ecology Institute.

Call for nominations 2016 in Marine Ecology

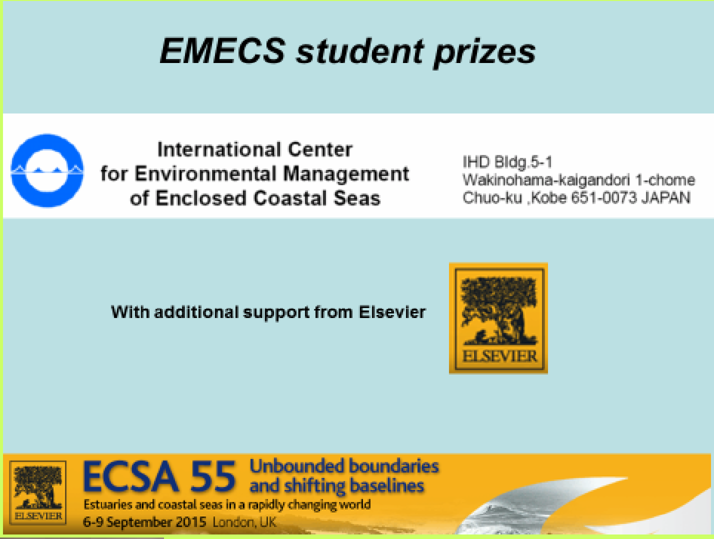
Nominations are invited from research ecologists worldwide. Candidates must be in agreement with the nomination, and with the attached requirement (for the ECI Prize) to write a book. Nominations should include a brief statement why, in the opinion of the nominator, the nominee qualifies for the prize, as well as the candidate's CV, publication list, and a short outline of the book that the candidate would wish to write if successful, with an expected completion date. Nominations and accompanying documents should be sent to the Director of the Ecology Institute, Professor Brian Moss (brmoss@liverpool.ac.uk) by March 15, 2016

Conference Report

Oral presentation:

Youta Sugai
Soka University, Japan
Seasonal variability in microbial abundance in the sea surface microlayer (SLM) in temperate coastal waters of Sagami Bay, Japan

Ken Schoutens
University of Antwerp, Belgium
Response of morphology and tissue properties of tidal marsh plants to wave activity




Franziska Bitschofsky receiving the first prize for the best poster

Poster presentation:

Franziska Bitschofsky
University of Rostock, Germany
Distribution of pore water phosphate and ammonium in sediments of a eutrophicated estuary of the southern Baltic Sea

Luis Henriquez
University of Tasmania, Australia
The influence of phsyical drivers in determining nutrient response (Impact) in coastal macroalgal reefs – Implications for spatial ecosystem-based management


Luiz Henriquez receiving the 1st prize for the best presentation at ECSA 55

ECSA LIFETIME ACHIEVEMENT AWARD PRESENTED TO PROFESSOR D MCLUSKY AT ECSA-55 LONDON, SEPTEMBER 2015

Firstly I would like to thank everyone in ECSA for the recent lifetime achievement award that the President, Dr Kate Spencer so graciously presented to me during the evening dinner cruise held at ECSA55. I wish to record my thanks both to Kate and to Mike Elliott and Geoff Millward who must have had a hand in drafting the citation speech, as well to all the Council Members who I understand voted for this award. It was deeply appreciated.

Life has a way of providing co-incidences, and for me it was a double co-incidence that the award was made whilst travelling on the Thames estuary on a paddle-steamer. Firstly, because as a school-boy of eight my class-room at Latymer Upper School at Hammersmith looked out on to the tidal estuary of the River Thames and I well remember watching the ebb and flow of the Thames when I probably ought to have been studying. Secondly, because the other estuary that featured in my early life was the Clyde estuary on whose banks my grand-parents lived, and where I lived during school holidays and spent most of my time there travelling on paddle-steamers!

During my lifetime involvement with ECSA (and its predecessor EBSA) there have been many changes in estuaries and our understanding of them. One of the main changes has been the appreciation that estuaries do exist. Back in the 1970s when EBSA started there were only two types of aquatic science, either marine science or freshwater science. Marine scientists were only interested in fully marine or saline waters, and freshwater scientists were only interested in fresh or drinkable waters. The bit in-between, what we all now recognise as estuaries, was either ignored or neglected. Studies of estuaries only began in the UK in the 1930s with the first recognition that estuaries existed and had often been allowed to become polluted. By the 1950s the first coherent legislation occurred to tackle estuarine pollution, through the establishment of River Purification Boards. But note the use of the term “river”.

So, when EBSA began in the 1970s its first priority was to tell the world that there really was a third aquatic environment, one that was neither marine nor freshwater, namely estuaries and brackish-waters. It is, I consider, one of the greatest achievements of EBSA/ECSA as well our sister American association (CERF) that the world of science and legislation recognises that estuaries actually exist. I also hope that my textbooks (*Ecology of Estuaries* and *The Estuarine Ecosystem*) have played a small part in implanting the name “estuaries” in students’ minds. Finally, however, linguistic differences between European countries has led to the term “transitional waters” as an administrative neologism in order to cover all estuaries and brackish-waters.

Within Britain the curious situation arose that the term “estuary” was used in a variety of legislation from shipping and finance acts through to pollution control, but the term “estuary” had never been defined in precise legal terms. One legacy that I am proud to have given to the world of estuarine science is in acting as an expert witness in a court case involving the Tax authorities (HMRC) of the UK government versus a shipping company (Western Ferries). The final judgment which now stands as UK law adopted a salinity-based definition of estuaries, which may be used in any other estuarine disputes.

Conference Report *continued*

The other major change in estuaries during my lifetime has been to observe the profound reduction in pollution that has occurred in almost every UK estuary and in many others world-wide. The public has perhaps not always realised how much has been achieved because of the conflation of "muddy" and "polluted" in their minds. During my time at Stirling University I gave many talks to public groups and almost always some-one would ask: "When is the Forth estuary going to be clean?" Every time I had to explain that it was in fact getting cleaner year-on-year, that pollution discharges to the estuary were going down year-on-year, and that a variety of legislation enforced by the River Purification Boards or Environment Agencies had had a significant effect in dramatically reducing pollution. But they would still comment: "Why are the waters still brown?" or "When will we have sandy beaches?" There remains a major educational task for future generations of estuarine scientists to explain that turbidity is not the same as polluted and that mud can be clean!

One way that this problem was regularly brought home to me was in dealing with students. Our final-year students had to complete a research project or dissertation. Often they would come to me and ask if they could do a project on pollution. I had to explain that many of the obvious sources of estuarine pollution no longer existed, but that less obvious or subtle forms of pollution did still occur. They would then refer to graphic images of pollution shown on the web pages of certain campaign groups, and were always surprised when I pointed out that many of these images were from several decades earlier. Indeed I am well aware of quotations from my own papers highlighting pollution in the Forth estuary in the 1970s and 1980s which are still being quoted by lobby groups without any recognition of the considerable improvements made since. The estuarine community has a duty to be honest and accurate, but must take care to be aware of the motives of those who might use their data selectively.

Conference Report *end*

During the latter years of my career I had the honour to be ECSA's editor of the journal *Estuarine Coastal and Shelf Science* (ECSS). During those ten years there were many changes, mainly from a "paper-based" submission system to an "online" submission. When I began as editor all the figures were re-drawn in-house for consistent style for example, but now authors draw their own entirely.

The change to online submission must not however be used as an excuse for a decrease in quality, and it is to the great credit of the present editors (Eric Wolanski, Mike Elliott and others) that they have strived to maintain quality – which means full peer review, in the face of pressures to speed-up the process.

I am well aware that some (not all) so-called online journals may only have limited (or no) peer-review and I would encourage ECSS and all ECSA members to do everything to tell the world of the quality of our own estuarine science journal, and of the need to maintain the highest standards in science publishing.

In 2011 the major reference work "*Treatise on Estuarine and Coastal Science*" was published. This 12 volume work involved 25 editors, with Eric Wolanski and me as chief editors, and the work of over 360 authors. It is a testament to how far estuarine science has progressed during my academic lifetime, that estuaries, brackish-waters or transitional waters, call them what you will, have progressed from being barely recognised as habitats to justifying this major reference work. This 12 volume book stands, I believe, as the best record to date of the estuarine world and the progress of our understanding over the past 40 years.

Throughout this period ECSA has had a vital role to play, especially through its meetings and publications, of keeping the position of the estuarine environment and ecosystem visible. Estuaries have undergone major changes in the period since the 1960s and 1970s and the foundation of ECSA, involving the expenditure of billions of pounds, euros or dollars in their clean-up, until the present day. At the same time, estuarine scientists have continued to show how fascinating and worthwhile it is to understand estuaries. Truly, ECSA has helped to reveal to the world that estuaries are important and that a "third" aquatic environment, the estuarine realm, really exists.

Donald S. McLusky

Forthcoming events

ANTWERP: 5-9 July 2016

ECSA Local Meeting - Estuarine Restoration: from theory to practice and back

For centuries, estuaries have been impacted by habitat reclamation, pollution, hydrological alterations and dredging among many other human uses leading to a large loss of biodiversity and ecosystem services. It is only recently that estuarine restoration became a hot topic and now many restoration projects are implemented worldwide.

The Schelde estuary situated in the north of Flanders and the south of the Netherlands is a typical example of this development. More than 150.000 ha of intertidal area was reclaimed over the last 1000 years and in the 20th century a large part of the estuary was anoxic for most of the year. Major waste water treatment and estoration works have taken place resulting in the improvement of the water quality and the recovery of the estuarine food web. Habitat restoration takes place at a large scale and range from vegetation management to managed retreat. In total more than 4000 ha of natural habitat will be restored. New techniques like flood control areas with controlled reduced tide were developed and implemented. The major project, the Kruibeke Bazel Rupelmonde flood control area, in total some 700 ha, becomes operational at the end of 2015 resulting in more than 300 ha of new tidal marshes. To celebrate this event the University of Antwerp (together with other local partners, universities and institutes) is organising an ECSA Local Meeting on estuarine restoration. The aim of the meeting is to bring together scientists and practitioners from over the world to exchange ideas and discuss the field of estuarine restoration.

Major topics dealt with during the conference are:

Setting the objectives of restoration
What measure is fit for which objective?
Evaluation of restoration measures: are the objectives achieved?
Ecosystem services: a driving force for future restoration?
Planning for estuarine restoration
the role of environmental legislation as a driver for restoration

Universiteit Antwerpen

ECOSYSTEM MANAGEMENT RESEARCH GROUP

Restoring hydrodynamics , Restoring morphology , Restoring the pelagic system, Restoring the benthic system, Restoring marshes, Restoring species (birds, fish, species specific projects), Restoring Biogeochemical functioning of marshes and flats

The conference will bring together both scientists and practitioners and result in new insights in the important field of estuarine restoration and lead to guidelines and concepts for further estuarine restoration projects. The projects along the Schelde estuary will be presented in several lectures and field visits to the most important sites will be organised during and after the conference.

For more information, see https://www.uantwerpen.be/en/rg/ecobe/ and http://www.ecsa-news.org/

On-going research

Response of morphology and tissue properties of tidal marsh plants to wave activity

Schoutens Ken, A. Silinski, J. Schoelynck, P. Meire, S. Temmerman
Ecosystem Management Research Group (ECOBE), University of Antwerp, 2610 Wilrijk, Belgium

Although we know that tidal marshes provide a largerange of ecosystem services(Costanza et al. 2008; Barbier et al. 2011), human activities combined with global change form a huge threat for their persistence (Kirwan and Megonigal, 2013; Schuerch et al., 2013). Whole coastal societies are endangered by sea level rise and the increasing number of big storm surges(Hinkel et al. 2014). Nevertheless, thoughtful management of coastal and estuarine ecosystems can help protecting these societies. For instance, the notion that coastal salt marsh plants attenuate waves and hence play a key role in ecosystem-based coastal defence is increasingly accepted among researchers and policy makers(Gedan et al. 2011; Cheong et al. 2013; Temmerman et al. 2013; Möller et al. 2014).

The capacity of a marsh to attenuate waves depends on plant morphological traits. Flume experiments showed that stiffer shoots and more biomass causes more wave attenuation under strong hydrodynamics (Penning et al. 2009; Bouma et al. 2010; Ysebaert et al. 2011; Bouma et al. 2013). For this reason, intertidal marsh vegetation and its morphological characteristics are important determinants for wave attenuation and thus the efficiency of the ecosystem-based coastal protection.

Apart from the attenuating effect of vegetation, waves in turn have also an effect on the marsh vegetation - both directly by drag and pulling force (challenging both, above and belowground vegetation parts) (Henry et al., 2013), as well as indirectly by determining the soil texture and composition by hydrodynamic sorting(Coops et al. 1991). In order to cope with the effects of these hydrodynamic forces, macrophytes are thought to use different strategies as proposed by the tolerance-avoidance trade-off theory (Coops et al. 1994; Puijalon et al. 2011). Enhanced flexibility enables the shoot to minimize and thus avoid the impact of external mechanical forces on the shoot (e.g. by bending they experience a reduced drag force from the currents) while, to the contrary, investments in rigidity, allow the shoot to tolerate hydrodynamic stress (Puijalon et al. 2011). Another response to hydrodynamics is the enhanced development of belowground biomassin order to stabilise the sandy soils, to enhance nutrient uptake and to give the plant more anchoring(Peralta et al. 2006).

Macrophyte shoots get most of their structural properties, i.e. rigidity or flexibility, from adjustments in the sclerenchyma cell walls composed out of strength molecules. For instance, cellulose aidsflexibility and lignin determines therigidity (Turner et al., 2001; Wang et al., 2012)). Apart from lignin and cellulose, biogenic silica (BSi) can also provide support to the shoot (Schoelynck et al. 2015). Since cellulose and lignin are molecules with high investment costs, Schoelynck et al. (2012) suggested a theory of alternative investment strategies where BSi could be a more cost-effective alternative.

On-going research *continued*

Therefore more wave exposed shoots are expected to use a stress avoidance strategy and therefore to invest more in flexibility in order to avoid hydrodynamic stress and thus to contain a higher amount of cellulose while higher silica and lignin concentrations are expected in the more sheltered locations in order to tolerate hydrodynamic stress(Schoelynck et al., 2012).

Researchers have mainly focussed on current-induced hydrodynamic stresses and their effect on marsh vegetation (Bouma et al., 2009; Puijalon and Bornette, 2006; Puijalon et al., 2005), although recent findings emphasise the role of wave exposure (Tonelli et al. 2010). Several studies compared species survival and morphology among water depth and differently wave exposed marshes (Karagatzides and Hutchinson, 1991; Coops et al., 1994; Clevering and Hundscheid, 1998). We explore the response of marsh vegetation (i.e. avoidance-tolerance trade-offs, tissue properties, etc.) to incoming waves within one species and exposure gradients within a tidal marsh in an integrated way towards wave attenuation.Since plant morphological properties differ between the stress avoidance and stress tolerance strategy, this has consequences for the plant's capacity to diminish hydrodynamic stress, which is important for the capacity of tidal marshes concerning coastal protection.

In this research along the brackish part of the Scheldt Estuary (Belgium) where*Scirpusmaritimus* is the dominating pioneer, we monitored plant morphology along awave exposure gradient within and between two sites with contrasting wave exposure. Our results show that the different soil abiotics between the sites can be attributed to the contrasting wave exposure as a result of hydrodynamic sorting. For instance, the availability of dissolved silica (DSi) is higher at the sheltered site. The calmer conditions allow more deposition of silica out of the water column (e.g. diatom shells), more silica retention by fine particles and more organic matter retention, i.e. organic matter is a source of silica after mineralisation and can enhance the silica cycle of the marsh (Struyf et al. 2005; Jacobs et al. 2012). This DSi can be seen as an indirect wave induced variable that might play an important role in determining the shoot properties. Indeed, a high correlation was found with the shoot BSi content (r=0.78) emphasising this statement.

Wave exposed shoots, both at the exposed marsh as well as the marsh edge, develop smaller and thicker shoots which are more flexible compared to the sheltered shoots (figure 1). This suggests that individual shoots of *S. maritimus* respond to wave exposure with a stress avoidance mechanism. Moreover, these properties were observed both within the same species as well as within one clonal stand of that species which indicates phenotypic plasticity.Avoiding stress means that the plants are less vulnerable to pulling forces or breaking, however as a consequence wave attenuation on the shoot scale is less effective. Although the differences in growth strategy, wave attenuation was similar or even better at the wave exposed sites.

On-going research *continued*

The reason for this outcome is not evident from our results.Nevertheless it indicates that although *Scirpusmaritimus* is able to adapt its morphology, biomechanical properties and chemical tissue composition to wave exposed conditions by avoiding physical stress on the small scale of a shoot, the wave attenuation capacity on a large scale of a pioneer marsh zone is not changed.

If you are interested in our research please feel free to contact us per email:

ken.schoutens@uantwerpen.be

alexandra.silinski@uantwerpen.be

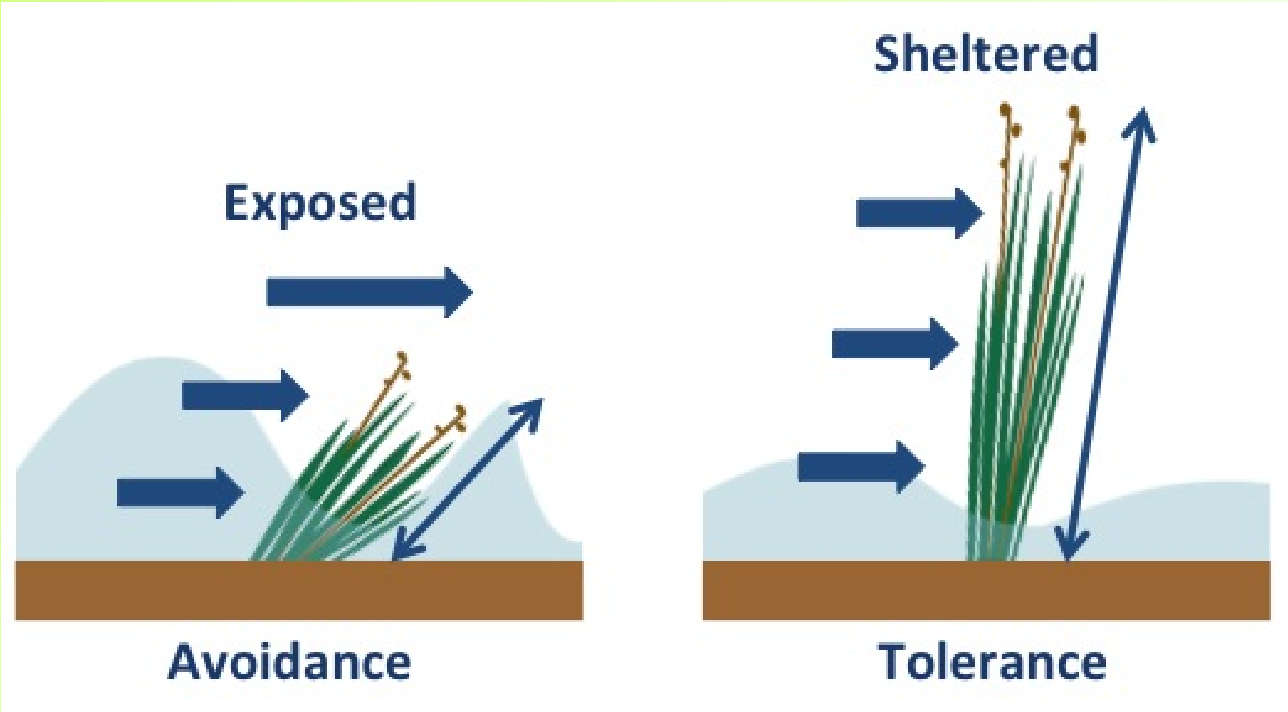


Figure 1: Schematic view of the response of marsh plants to contrasting wave exposure. Wave exposed shoots have a smaller stature and are more flexible, suggesting an avoidance strategy compared to sheltered shoots which are taller and stiffer, suggesting a tolerance strategy.

Figure 2: Example of the different morphologies (size) within one species and one clonal stand which indicates the phenotypic plasticity of Scirpusmaritimus.

Figure 3: Picture of one of the field sites. The shipping channel passes close to the marsh.

Membership

Estuarine and Coastal Sciences Association

http://www.ecsa-news.org

APPLICATION for MEMBERSHIP

Please return this form to the Membership Secretary at:

Dr Clare Scanlan, SEPA, Inverdee House, Baxter Street, Torry, Aberdeen AB11 9QA, Scotland, UK

Tel: +44 (0)1224 266617 Fax: +44 (0)1224 896657 Email: clare.scanlan@sepa.org.uk

PLEASE COMPLETE LEGIBLY IN BLOCK CAPITALS

Title________First name ______________________Family name__________________________________

Contact Address____

____

____

City ____________________________________ Country ____________________________________

Post code/Zip code ____ Mobile no.______________________________

Email address____

SUBSCRIPTION RATES (for one year): Please circle membership type & rate applied for

Category of Membership	Yearly payment by Standing (Banker's) Order only	Yearly payment by all other means
Annual Member	£35	£36
Institutional member	£100	£100
Sponsoring member	£250	£250

Student member (3 years)#	£30 (for 3 year membership)
Institution of study	
Course	
Current year of study	

#Students must provide details above of course of study

Please tick method of payment

Paypal*		Standing order**		Cheque***		Bank transfer****	

* PayPal payment can easily be made using the PayPal link on the Association's website and is particularly recommended for payments from outside the United Kingdom

** For payment details please contact the Membership Secretary or see page 2 below

*** Cheques should be made payable to: *Estuarine and Coastal Sciences Association*

**** For bank account details please below & page 2 or contact the Membership Secretary

IBAN No. GB86 BOFS 8002 2400 3730 53 **BIC: BOFSGB21216**

Subscription to Estuarine & Coastal Shelf Science - **Online access @ £44 per annum** - **Online & print at £297 per annum**	
If you wish to subscribe to online access to the journal ECSS, please indicate this below and add the cost to your payment.	
I wish to subscribe to ECSS	Yes / No
Online only Yes / No	Print & online Yes / No

Membership *end*

To pay by Standing Order:

Please complete this form in BLOCK CAPITALS & **return it to your bank**

APPLICANT'S BANK DETAILS	*APPLICANT'S DETAILS*
To:______________________________ (Bank)	Name:______________________________
Address:______________________________	Address:______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
	______________________________
Sort Code:______________________________	Account No:______________________________

Please pay to the account of the:

ESTUARINE AND COASTAL SCIENCES ASSOCIATION
Bank of Scotland PLC
300 Lawnmarket, Edinburgh, EH1 2PH
Account number: 00373053
Bank sort code: 80-02-24

The sum of £_____ on receipt of this order and thereafter £_____ on 1st April of every year until further notice.

Signed: Date:

N.B. If setting up a standing order, please remember to complete an application form and send it to the Membership Secretary along with evidence of standing order

ECSA Bulletin

The ECSA Bulletin is produced twice a year. Material for the Bulletin must be submitted to the Editors by December 1 or June 1, for issues appearing in January and July respectively. We would be pleased to receive short articles and notices of publications and meetings. Information on change of address, and applications for membership should be sent to the Membership Treasurer and not the Editors, correspondents or publishers.

Bulletin Editor
Jean-Paul Ducrotoy
Institute of Estuarine & Coastal Studies
University of Hull, Hull, HU6 7RX (UK)
Tel: +33 0322 238 074
Mobile: +33 0633 874 524
e-mail: jean-paul.ducrotoy@hull.ac.uk

Membership Treasurer
Dr Clare Scanlan
Senior Marine Ecologist
SEPA
Inverdee House, Baxter Street
Torry, Aberdeen AB11 9QA (UK)
e-mail: clare.scanlan@sepa.org.uk

ECSA Web Master
Karen L. Nicholson
Institute of Estuarine & Coastal Studies
University of Hull, Hull, HU6 7RX (UK)
e-mail: k.l.nicholson@hull.ac.uk
Tel: (+44) 1482 463167

e-newsletter Editor
Dr Anita Franco
Institute of Estuarine & Coastal Studies
University of Hull, Hull, HU6 7RX (UK)
e-mail: a.franco@hull.ac.uk

Workshop Organiser
Teresa F. Fernandes
Napier University, Edinburgh EH10 5DT (UK)
e-mail: tfernandes@napier.ac.uk

Association's *Editor of Estuarine, Coastal & Shelf Science*
Mike Elliott
Institute of Estuarine & Coastal Studies
University of Hull, Hull, HU6 7RX (UK)
e-mail: mike.elliott@hull.ac.uk

Designed, printed by:
Alphaprim' - 75, chaussée du Bois - F80100 Abbeville
Tél. +33 (0)3 22 20 37 77 - www.alphaprim.net

Council of the Estuarine & Coastal Sciences Association

Estuarine & 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 memberships forms from:

ECSA Membership Treasurer,
Dr Clare Scanlan,
Scottish Environment Protection Agency (SEPA),
Inverdee House,
Aberdeen AB11 9QA, Scotland, UK

or from the ECSA website:

www.ecsa-news.org/joiningECSA.htm