

**THE INTERTIDAL ECOSYSTEM:
THE VALUE OF IRELAND'S SHORES**

Edited by
James G. Wilson
Department of Zoology, Trinity College, Dublin 2

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FOREWORD: THE INTERTIDAL SYSTEM

Geoffrey O’Sullivan

Marine Institute, 80 Harcourt Street, Dublin 2

Email: geoffrey.osullivan@marine.ie

On behalf of the Marine Institute, I would like to commend the initiative by the Royal Irish Academy’s National Committee for Biology in organising this exciting Conference on “The Intertidal System” and to say how delighted the Marine Institute is to be one of the sponsors.

The Intertidal Zone is where the sea meets the land. It is, in many cases, our first personal contact with the rich biological diversity and form of marine life. Indeed many a career in marine science can trace its genesis to a youthful experience splashing around in an intertidal pool.

Ireland is fortunate in having a diverse coastline. Extending for over 7,500 km, our coastline encompasses a broad range of intertidal habitats from rocky shorelines to sandy beaches, muddy lagoons and estuarine mud flats. Many of these habitats are of national and/or international importance and warrant conservation whether as Special Areas of Conservation (SACs) or other designations.

While we can appreciate the aesthetic and “*quality of life*” value of the coastal zone, though perhaps not put an economic value on it, we very often overlook the very significant ecological function provided by the intertidal zone. In this context, we look forward to the keynote presentation by Dr Wilson of the Gund Institute for Ecological Economics (Vermont, USA) who are internationally recognised experts in this field.

Intertidal biodiversity provides us with a measure of environmental quality, sentinel species such as the dogwhelk (*Nucella*) and the mussel (*Mytilus*) provide a warning of environmental pollution, while species such as the barnacle are being used to monitor climate change. As a laboratory, for educational and experimental purposes, the intertidal is unique. It provides many with their first introduction to taxonomy, and is a natural laboratory for experiments in physiology, form and function.

As to the sustainable economic value of intertidal resources, I was surprised to learn that the lowly periwinkle (*Littorina littorea*) is worth some €6 million/annum to the economy. The Irish Seaweed Centre informs us that intertidal seaweeds contribute another €6 million/annum. The value of intertidal aquaculture is well known and I have no doubt that others will give examples of the economic value of intertidal resources.

And who knows what new developments in marine biotechnology might provide? Perhaps the mussel and barnacle will give up their illusive secret to “*the glue that sets underwater*”.

A Conference like this fulfils many functions:

- It provides an opportunity to review existing and on-going work. Many of you will be familiar with the results of the EU Life BioMar project. But how many are familiar with the results of the EU *INTERREG-II* funded SensMap project which has mapped intertidal habitats along the east coast or of the JNCC Directory of the Celtic Seas and Coasts?
- It provides an opportunity to network with colleagues, find out what they are doing and share experiences and approaches to common problems.
- It provides an opportunity to identify gap areas and propose ways to address these.
- In this context, we hope and trust that RIA will produce a Proceedings of this Conference.

This decade, the first decade of the New Millennium, promises to be an exciting era for Irish marine science. Through NDP funding, marine research facilities and capacities in the third level sector and in state research organisations are being strengthened. Competitive research funding is available like it never was before from both European Union–6th Framework Programme (2002–2006), Life, and INTERREGs IIIA (Ireland/Wales) and IIIC (Atlantic Rim) and national sources (National Development Plan). Partnership, both between Irish institutions and with the international scientific community, will be the key to success.

PREFACE

We live in a world increasingly impacted by man's activities. Human population continues to grow, and more importantly perhaps human expectations continue to grow. Since 1950 the population of the world has increased from 2.5 billion to over 5.4 billion. Of the present total, almost three-quarters are accounted for by the developing nations, whose aspirations, not unnaturally, are to raise their lifestyle to the level enjoyed by the developed countries. Over the next three decades not only will another 3 billion people will be added to the world's population, but also this increase will be in those underdeveloped countries striving to raise living standards. Increasing numbers of people combined with demand for a better standard of living will lead inevitably to increasing pressures on natural resources.

These pressures are most acutely felt in the intertidal system. The bulk of the world's population lives near, or on, the coast and it is here that the demands on the system are greatest.

Over the past thirty years or so there has also been an increasing awareness of environmental matters and environmental problems, coupled with a realisation that technology alone is not going to resolve all the problems we are faced with. It is also fair to say that many of the earlier doomsday predictions have not been borne out, and although food supply, to take a popular example dear to all ecologists' hearts, is certainly a problem in some parts of the world, the global system as a whole does still produce enough to go round, and the problem is one of distribution and allocation and local imbalances of supply and demand. Local pressures are often ignored or passed over in the quest for the 'big picture', but these resources are vital elements in the quality of life—or indeed in some cases in the very continuance of life—for those local inhabitants.

The contributions in this volume cover a wide range of interests. Some emphasise the utility of the intertidal ecosystem in elucidating ecological principles and hopefully will stimulate a wider investigation and a deeper understanding of their mechanisms; some consider the system from a socio-economic point of view, with particular attention to the uses and stresses imposed by human activities on the system; and some look at the practical management aspects especially in view of the over-arching EC Directives.

The range of contributions reflects also a range of scales. The bulk of the contributions are intended to reflect, and in places review current knowledge and activities in Ireland, focussing on specific locations and/or processes. The three international contributions have a dual function: firstly to put the Irish research into an international context and secondly to draw attention to some of the current thinking in selected areas. For completeness, and as a record of the meeting, the abstracts of posters are also included.

The opening contribution by Wilson *et al.* builds on Bob Constanza *et al.*'s seminal *Nature* paper on the value of ecosystem goods and services. This is an important and expanding field, in terms of how we think of natural systems, and in particular of how to widen the appreciation of what they contribute to our present lifestyle beyond the

immediate economic resource exploitation. Thus the value of a system is linked to the function, and so to understand value, we must understand function. The paper by Costello and Emblow is driven by conservation and biodiversity considerations and categorises the system at the level of the biotope to provide the framework of a classification scheme for Ireland. Such classifications rely on two premises: firstly that the classification units themselves are sufficiently well-defined to serve as surrogates for the properties we wish to measure, such as biodiversity; and secondly that a change in the driving forces, whether it be natural climate change or anthropogenic pollution, will result in a measurable change in designation. Management is the prime consideration in Merne's contribution, which is placed in context of the EU Birds Directive. The Directive places statutory duties on Government in terms of the designations and management of coastal bird populations and is a salutary example of an instance of the value of one particular component ecosystem and the extent to which it is driving current practice.

Several contributors link processes and concepts. Jeffrey and Hayes highlight the basic trophic level, the primary producers, and draw attention to the fragmented nature of much of our knowledge. The primary producers illustrate a major difficulty in understanding function in that minor disruption may actually augment system function (e.g. eutrophication) and this phenomenon is further explored both in Colijn and van Beusekom and in Jennings and Jeffery. The former draw attention to the fact that various initiatives in the Wadden Sea have resulted in significant changes in nutrient input. However, while they acknowledge that the overall consensus suggests a reduction in eutrophication, but the actual mechanisms of the reduction, and the nature of the link between nutrients and productivity (as opposed to biomass) is still not entirely clear. Jennings and Jeffery provide another good example of this process from Dublin bay, The nutrient delivery fuelling eutrophication is itself a function of another process, namely the remineralisation of particulates, and this illustrates the way in which system processes are interlinked.

Boaden's paper on meiofauna encapsulates many of the limitations imposed in terms of understanding the system. The meiofauna are among the most important contributors to intertidal system function, yet taxonomic data is the best aspect of our knowledge, and even that is severely limited in terms both of the taxa themselves and localities for which lists are available. Quantitative data for the Irish situation is even scarcer and almost nothing has been done in terms of process or function. In many cases we lack even the basis to be able to extrapolate from other work abroad to Ireland.

The intertidal system has provided the inspiration for some fundamentals of ecological science, and in particular through the consideration of population dynamics on the rocky shore. McGrath provides a detailed analysis for the blue-rayed limpet, which shows the importance of its association with the shore algae and of secondary settlement in its life history. The interaction of species within the community is further elaborated by Crowe and by Johnson. Crowe brings together a wide range of examples to consider what happens when species are taken out of a system. Will system function (and by extension system value) be altered? And if so, can we predict how, and by how much, it will be

altered? Johnson's paper considers that final question in the light of what we know of community succession of the temperate rocky shore and gives examples of current models of the system. In this he shows the potential of mathematical modelling and how the modelling approach compliments both time series data and experimental studies and how it can be applied to a wider range of contexts

Wilson's paper looks at the link between system properties and system function, with emphasis on the long-term changes in the system, and echoes the queries posed by Crowe (above), for the sand and mud communities. In the context of long-term sustainability, what aspects should we concentrate on preserving and is there anything we can use as an early-warning indicator of system deficiency or malfunction?

The papers are brought to an end by the contribution from Heip *et al.*, which places much of the Irish work presented previously in an international context. The Westerschelde is a well-studied system, and this example illustrates not only the level of information which is a pre-requisite for any interrogation of the system, but also the kinds of questions which can then be posed and the management advantages that derive from it.

This selection of papers is intended to serve several ends. Firstly, they have been brought together to bring out many of our ideas about the scientific worth and also the practical usefulness of intertidal systems as objects of investigation. Secondly, they are intended to highlight the way in which "pure" science underpins much of the "applied" practice and how anthropogenic impacts derive from the responses of the natural environment. Thirdly, they are intended to encourage further investigations in the whole field of intertidal ecology, and of system function in particular. As our understanding of the reactions of organisms to changes in the environment increases, so will our ability to predict and hopefully avert future deleterious ecological changes—which after all is what is at the base of sustainable development. Fourthly, the volume is written as a guide to managers and administrators or others who may not be biologists by training or inclination, but whose work or interests bring them into contact with the sorts of situations described herein. Finally, this volume has been written to encourage. To encourage present and future students with the fascination and the utility of such studies, to encourage our colleagues, to whom due acknowledgement for their encouragement in turn is owed, to continue with such work, and finally to encourage non-specialists that such knowledge and understanding are not only necessities, they also have a rationale and an allure all of their own.

As with all volumes of this kind, it would not have been possible to bring it together without the generous help of many individuals and institutions. Thanks are due to all the participants, not only those who presented papers, and whose contributions are published herein, but those who contributed to discussions, both formal and informal, during the meeting. Many also discovered that their contribution extended well beyond the meeting in their refereeing of these contributions, and their efforts have ensured the standard of this volume. Thanks are also due to the sponsors, and in particular to the Marine Institute and to the IRTU, and to the Royal Irish Academy as hosts without whom we could not

have attempted anything on this scale. My personal thanks, as editor, to the organising Committee (listed below), for their ideas, their support, and their intellectual and physical contributions to the organisation and the running of the meeting and to the production of this volume. Above all, thanks are due to Ruth Hegarty of the RIA, who has put in as much work as anyone on the whole thing and especially for keeping it all together.

ORGANISING COMMITTEE

Dr. J. Breen (Industrial Research and Technology Unit, DETI, NI)

Prof. M. Guiry, (Martin Ryan Institute, NUIG)

Prof. D. Jeffrey, (School of Botany, TCD)

Dr. C. Moriarty (Royal Irish Academy)

Prof. A. Myers, (Zoology Dept., UCC)

Mr. G. O'Sullivan (Marine Institute)

Dr. J. G. Wilson, (Zoology Dept., TCD)

James G. Wilson

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