Workshop program

Day 3, Tuesday, September 2	
3:00 pm	*Workshop 1:* Seagrass management: priorities, credibility and scale Coordinators: P. Erftemeijer, M. Fonseca, R. Coles
7.30 pm	*Workshop 2:* A conceptual framework for global seagrasses Coordinators: T. Carruthers, G. Di Carlo
Day 4, Wednesday, September 3	
3:30 pm	*Workshop 3:* Evaluating the mechanisms of seagrass dispersal–what are the functions of dispersal in the spatial and temporal dynamics of seagrass meadows and seagrass ecosystems Coordinator(s): J. Kenworthy, J. Jarvis, G. Di Carlo and M. Rasheed
Day 5, Thursday, September 4	
10:30 am	*Workshop 4:* Regional web pages Coordinator(s): M. Waycott, S. Livingstone, L. McKenzie, J. Mellors
Day 6, Friday, September 5	
10:30 am	*Workshop 5:* Plant-Animal-Bacteria interactions Coordinators: K. Heck, D. Welsh, B. Peterson

Workshop details follow, it is very important that you read these before the meeting to assist in preparation for the activities.

Workshop 1—Seagrass management: priorities, credibility and scale

Coordinators: Paul Erftemeijer, Mark Fonseca and Rob Coles

While we all appreciate the values and services that seagrass ecosystems provide, it is becoming increasingly clear that seagrass resources worldwide are being lost at an alarming rate due to human activities. Those charged with the task to manage and conserve seagrass resources are faced with an ever-increasing complexity of threats from multiple sources and at a variety of spatial and temporal scales, against an ever-increasing population pressure on the coastal zone and a strong drive for economic development. On the other hand, research and monitoring is revealing that many seagrass systems are more dynamic than previously thought and often display remarkable resilience, including the ability to recover from disturbances. A range of management tools have been developed and applied to manage human activities that (can) have a detrimental effect on seagrasses, including legislation, marine protected areas, environmental impact assessment, restoration, raising awareness, etc. Given the present-day rate of seagrass loss, however, we are clearly not (yet) winning the battle.

In this workshop we aim to discuss three issues of major importance in seagrass management: priorities, credibility and scale. The first issue (priorities) refers to the fact that resources (financial, time, man-power, authority) available to managers are typically limited. What would constitute the best investment of your time and money (e.g. building wastewater treatment facilities or marine patrols to enforce boating rules)? What would be the best way to determine priorities? How to map and assess risks, compare alternatives and evaluate costs and gains? Could priorities differ in different regions of the world (e.g. Canada versus Zanzibar)?

The second issue (credibility) refers to the reliability of our specialist advise, impact predictions, setting of water quality thresholds, recommended dredging criteria, and so forth. What if they take us to court to prove our predictions or claims? Can we really substantiate our criteria with judicially acceptable (scientific) certainty? What will happen if our predictions prove to be incorrect? How should developers and decision-makers evaluate our advise and arguments?

The third issue (scale) refers to the fact that there is often a mismatch between the scale of problems and the scale of information. For example, how much seagrass loss would have a significant impact (let's say 50% reduction) on dugong populations? Will setting aside a few isolated marine protected areas do the job? What really constitutes a 'significant' impact (in terms of scale: % of total) or acceptable loss? Or, for example: what would happen if we were to lose all the seagrass in the Arabian Gulf? Scale is also a major issue in seagrass restoration (e.g. size and costs of transplanting vs. scale of loss, and timescale of restoration vs natural recovery).

In this workshop, we hope to draw from your expertise and discuss ways to move forward to improve efforts to manage and conserve seagrass resources worldwide. Our overall aim is to synthesize our collective expertise and views with regard to seagrass management, and to identify research priorities for seagrass management. The findings of the workshop will be summarised in a scientific paper.

To ensure that we will have an interesting and successful workshop session, we urge participants to prepare themselves, by: [1] bringing information on relevant case studies from your region; [2] reading some of the following revelant papers: (Kirkman and Kirkman, 2000; Coles and Fortes, 2001; Duarte, 2002; Owen et al., 2005); [3] think about what we as scientists can do to improve seagrass management.

During the workshop we will:

1. Have brief introductory presentations by the workshop moderators
2. Break into groups to discuss the different topics and issues (priorities, credibility, scale)
3. Assign one team member from each group to take notes and present outcome
4. Reconvene and report back from working groups
5. Wrap up and follow-up (publication, assign tasks)

Coles, R. and M. Fortes, 2001. Protecting seagrass – approaches and methods. Chapter 23 in: F.T. Short and R.G. Coles (Eds.) Global Seagrass Research Methods, pp. 445-463.

Duarte, C.M., 2002. The future of seagrass meadows. Environmental Conservation 29(2): 192-206.

Kirkman, H. and J.A. Kirkman, 2000. The management of seagrasses in South East Asia and Australia. Biologia Marina Mediterranea 7: 305–319.

Owen, R. C. Mitchelmore, C. Woodley, H. Trapido-Rosenthal, T. Galloway, M. Depledge, J. Readman and others, 2005. A common sense approach for confronting coral reef decline associated with human activities. Marine Pollution Bulletin 51: 481-485.

For questions, suggestions, comments or to send relevant material, please contact Paul Erftemeijer at paul.erftemeijer@wldelft.nl

Workshop 2—A conceptual framework for global seagrasses

Coordinators: Tim Carruthers, Giuseppe Di Carlo and Fred Short

Although we work on different aspects of seagrass biology, associations, management and restoration, it is often challenging to establish exactly how far we can generalize conclusions from a particular study. Can we apply conclusions from *Zostera* to *Thalassia*, *Posidonia* or *Halophila*? Can we expect the same responses from *Thalassia* growing through coral heads in coarse carbonate sand, to shoots growing in reduced salinity, fine silicate muds? Often not – but although we recognize the huge diversity and morphological variation in seagrass occurrence and physiological responses, how do we classify these differences so that we can address large scale issues such as regional or global seagrass changes? At ISBW6 in Townsville, a start was made on developing conceptual diagrams of key processes from many locations around the world. Since then, two publications; Short et al. 2007: Global seagrass distribution and diversity: A bioregional model, and Carruthers et al. 2007: Seagrasses of south-west Australia: a conceptual synthesis of the worlds most diverse and extensive seagrass meadows have continued to develop such a framework.

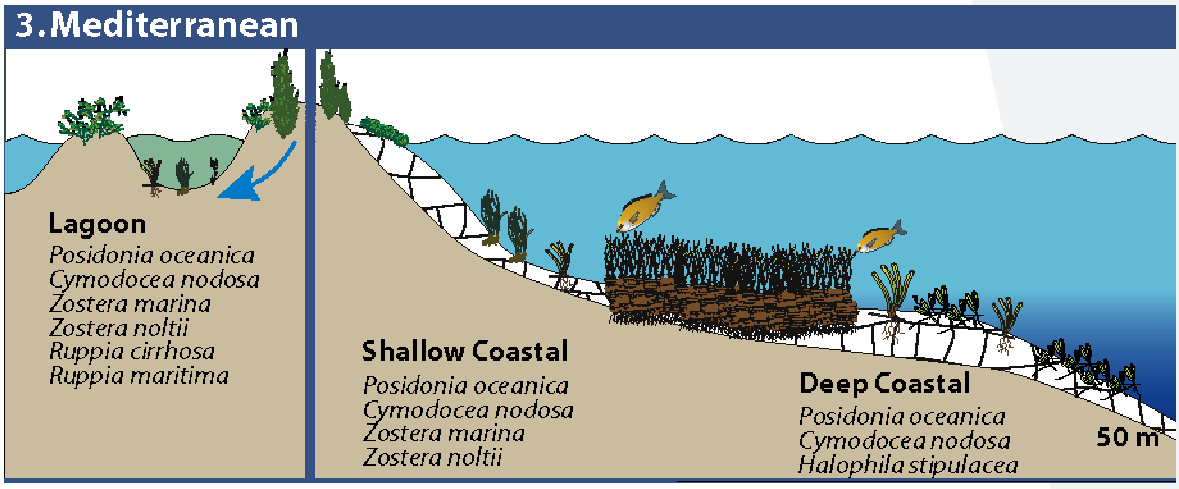
In this follow up workshop at ISBW8 we plan to work within the global regions defined by Short et al. and develop regionally based specific habitats to example the key seagrass habitats within each region (e.g. Carruthers et al for SW Australia). The resulting diagrams and summaries will be placed onto the new ISBW website, and ultimately we aim to produce a collaborative synthesis paper, authorship inclusive of interested workshop participants. The paper will also synthesize some key ecological and physiological data from these different regions into some key synthetic tables.

Our overall aim is to synthesize our collective knowledge of seagrasses around the globe and present it both on the web and in journal publication format, for our own use and also to assist others in many branches of seagrass research and management.

If we are going to succeed at producing something from this effort, it would help greatly if participants could bring 1-5 key papers from their region (on seagrass processes, features, habitat function, threats etc).

During the workshop we will:

1. Brief introductory presentations (including a recap from ISBW 6).
2. Break into groups by knowledge of global regions
3. For sub regional habitats (Short et al), synthesize ideas and key features and threats
4. Assign one team member to take notes, and compile into two paragraphs of referenced text.
5. Determine list of interested participants in following through on a publication – assign tasks.



Carruthers, TJB., Dennison, WC., Kendrick, GA., Waycott, M., Walker, DI. and Cambridge, ML. 2007. Segrasses of south-west Australia: A conceptual synthesis of the world's most diverse and extensive segrass meadows. JEMBE 350: 21-45

Short, F., Carruthers, T., Dennison, W. and Waycott, M. 2007. Global seagrass distribution and diversity: A bioregional model. JEMBE 350: 3-20

Workshop 3—Evaluating the mechanisms of seagrass dispersal: what are the functions of dispersal in the spatial and temporal dynamics of seagrass meadows and seagrass ecosystems?

Coordinators: J. Kenworthy, J. Jarvis, G. Di Carlo and M. Rasheed

Many seagrass ecosystems are spatially dynamic, varying at temporal scales ranging from just a few weeks up to decades, and in some cases, even centuries. While many seagrass meadows appear to persist for long periods of time there are many reports of seagrass meadows disappearing and re-establishing. How well do we understand the principal biological and physical mechanisms driving these dynamics? A fundamental knowledge of how and when seagrasses disperse is essential to our understanding of the expansion and decline of seagrass meadows. More importantly, if we are going to develop forecasting models for predicting the distribution and abundance of seagrasses under different environmental conditions we are going to need a functional working model of dispersal that includes biophysical parameters. The goal of this workshop is to begin to develop a general conceptual model of seagrass dispersal which can serve as the basis for individual species based models as well as for models of communities and bioregions. The table below illustrates a general list of known mechanisms and the potential scales at which they operate.

Mechanism	Spatial Scale	Temporal Scale
Pollen	<1 m - 10 m	Annual
Fruit	<1 m - >km	Annual and/or event
Seed	<1 m - >km	Annual and/or event
Clonal (continuous)	<1 m - km	Annual and/or continuous
Clonal (fragments)	<1 m - km	Continuous and/or event
Animal/Human	<1 m - >km	Unknown

For species that reproduce sexually, pollen dispersal is the first step in the process. Sexually reproducing populations also exhibit fruit and seed dispersal while most all seagrasses extend their occupation of space by asexual reproduction including clonal growth and fragment dispersion. We also must consider human intervention, e.g., transplanting, habitat fragmentation and accidental transport of species. The models must incorporate the implications of spatial and temporal scales relevant to dispersal. Spatial scales range from < 1.0 m for several mechanisms, up to many kilometers for fruits and clonal fragments. Animal and human assisted dispersal may extend across entire bioregions leading to non-indigenous species introductions. Time scales may be annual for sexual reproduction and seasonal for clonal dispersal while event driven stochastic processes such as severe storms may be important for local as well as long distance dispersal.

During the workshop we will:

1. Provide a brief introductory presentation of dispersal mechanisms and a conceptual model with a table relevant to the different dispersal mechanisms and develop a list of key questions relevant to dispersal dynamics.
2. Break into groups by knowledge of dispersal mechanisms (e.g.; seed vs. clonal vs. fragments) Assign one team member to take notes, and compile into two paragraphs of referenced text.
3. Develop sub-models for each dispersal mechanism – assign these to appropriate species.
4. Determine list of interested participants in following through on a publication – assign tasks.

Workshop 4—seagrassonline.org, towards a comprehensive web site as a portal for seagrass information: ISBW8 developing regional web pages

Developed by Michelle Waycott, Ainsley Calladine, Bill Dennison, Tim Carruthers

To be presented at ISBW8 by Michelle Waycott (via remote presentation), Suzanne Livingstone, Len McKenzie, Jane Mellors, Ainsley Calladine (remote assistance)

The web has become the first choice for scientists, managers, students and the public for information on almost every topic. Recent publications have clearly shown that seagrasses are not perceived to have the charisma of coral reefs and mangrove forests, resulting in less scientific publications per year, and a lot less media attention (Duarte et al., 2007). Through your participation in ISBW you can play a key role in addressing this challenge, which will ultimately not only help to increase public awareness of seagrass issues and challenges to encourage better management of our coastal habitats but increase opportunities to fund research activities to fill knowledge gaps. The development of this resource was made a high priority at ISBW7 in Zanzibar, to that end we have initiated a new seagrass WWW domain name: seagrassonline.org

We have used this domain to house the WSA web site (wsa.seagrassonline.org), the ISBW8 web site (isbw.seagrassonline.org) and have begun developing the core content site.

In this workshop, we are going to work on the development of materials to populate a web site portal – to assist seagrass scientists, students, managers and the public to easily access key information about seagrasses and seagrass issues around the world. We aim that this site will in future contain discussion forums and other features that can help us, the regognised face of the seagrass community, to communicate and be aware of basic knowledge, current issues and future prospects.

A first stage to populating the web site is to summarise our knowledge of regional seagrasses and any other regional themes we wish to explore. In our presentation we will outline the conceptual structure of the web site. This will provide us with a framework to develop content. For example, the paper by Short et al. 2007 describes six clear biogeographic regions (bioregion) for seagrasses around the world. Within each global bioregion there is significant diversity to the types seagrass communities present and threats to these vary dramatically. As outlined by Orth et al. 2006 these threats are critical and recent analyses (see the poster Waycott et al. Global seagrass trajectories) show overall declines.

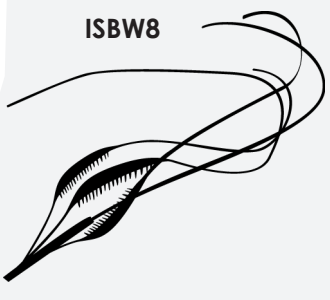
During the workshop we will:

1. Have a brief introductory presentation to outline the WWW site and how we want to progress its development
2. Discuss the basic strategies for summarising information to be presented on a website (view draft) and outline the goals of the workshop activity
3. Break into groups to work on regions for the website
4. Re-convene and report back from working groups
5. Determine those interested in continuing this effort and assign activities coordinators
6. Next day view draft WWW pages thanks to the time zone differences with Australia

DUARTE, C. M., W. C. DENNISON, R. J. ORTH, AND T. J. B. CARRUTHERS. 2008. The charisma of coastal ecosystems. Estuaries and Coasts 31: 233-238.

SHORT, F. T., T. J. B. CARRUTHERS, W. C. DENNISON, AND M. WAYCOTT. 2007. Global seagrass distribution and diversity: A bioregional model. Journal of Experimental Marine Biology and Ecology 350: 3-20.

ORTH, R. J., T. J. B. CARRUTHERS, W. C. DENNISON, C. M. DUARTE, J. W. FOURQUREAN, K. L. HECK, A. R. HUGHES, G. A. KENDRICK, W. J. KENWORTHY, S. OLYARNIK, F. T. SHORT, M. WAYCOTT, AND S. L. WILLIAMS. 2006. A global crisis for seagrass ecosystems. Bioscience 56: 987-996.



Workshop 5—Plant-Animal-Bacteria Interactions

K.L. Heck, Jr., B.J. Peterson, D.T. Welsh

During the past two decades we have learned much about the importance of plant-animal interactions (in the broad sense) in seagrass meadows, especially those involving herbivory. Perhaps this should not be surprising, given the critical importance of plant-animal interactions in the better-studied terrestrial systems (e.g., pollination and microrhizae), and the marine fossil record that shows that seagrasses and animals have evolved and interacted with each other since the early days of seagrass existence. Two particularly long-lasting associations, clearly reflected by the fossil record, are between seagrasses and sirenian herbivores and between seagrasses and lucinid bivalves that are nourished by sulfur-oxidizing bacteria.

In this session we review and reassess the growing body of evidence on the importance of plant–animal interactions in seagrass meadows. We focus special attention on recent studies that have examined 1) seagrass-herbivore interactions and 2) seagrass-bacteria interactions in the rhizosphere, but we also consider a number of other examples of important seagrass-animal interactions.

In the area of herbivory we consider direct and indirect effects of grazing on above- and belowground seagrass tissues, mesograzer consumption of algae growing on seagrass leaves and its impact on seagrass growth and survival, and reduction of water column particles and deposition of organic matter by suspension feeders in seagrass meadows. The major conclusion is that diverse grazing pathways provide an important conduit for the transfer and recycling of energy and materials between primary producers and higher order consumers, and that there are many positive and negative interactions among herbivores and seagrasses.

With respect to seagrass-bacteria interactions, we review evidence for the great importance of bacterial populations in turning over organic matter and in driving the major elemental cycles in seagrass-dominated ecosystems. We will focus on the manner in which seagrass roots and animal burrows provide oxygenated micro-habitats for bacterial populations in otherwise inhibitory sedimentary environments, and the role of microbial processes in buffering ecosystems against the negative effects of eutrophication. In addition, we discuss interactions between seagrass and bacterial symbionts and the influences of these interactions on nutrient cycles. Symbioses of particular interest and importance are those between seagrasses and nitrogen-fixing sulfate reducing bacteria in the rhizosphere, and the endosymbioses between chemoautotrophic sulfur oxidizing bacteria and benthic invertebrates, and their effects on the chemistry of the seagrass rhizosphere.

Other important plant-animal interactions that we consider are parasite-seagrass interactions, and bioturbation and its positive and negative effects on seagrasses. In each topic area we will review the current state of knowledge, identify important gaps in understanding and point out fertile avenues of future investigation. We aim to be provocative and we hope to spark spirited discussion.