LITTORAL ZONE

Duarte, Carlos M
IMEDEA (CSIC-UIB), Instituto Mediterráneo de Estudios Avanzados, CSIC-Univ. illes Balears, Spain.

Keywords: Littoral zone, extent, ecosystem services, biogeochemical fluxes, production

Contents

1. Introduction

The littoral zone is operationally defined here as the fraction of the ocean that supports benthic plants, whether macro- or microscopic. The littoral zone extends from the upper intertidal down to the depth to which 0.1 % of the irradiance incident on the surface penetrates, which is the minimum irradiance required for the maintenance of benthic primary producers. The range of plants to be encountered in the littoral zone is broad, encompassing higher plants (mangroves, salt marsh plants, seagrasses), macroalgae, and microalgae, both free-living and endosymbiotic.

The ecosystems these plant communities develop support lush animal and microbial communities, which confer on the littoral zone a critical importance as the most important reservoir of plant and animal species in the ocean. Littoral ecosystems are highly productive and are responsible for a significant share of the cycling of carbon and nutrients in the ocean, rendering the littoral zone a key site for biogeochemical processes in the ocean. The role of the littoral zone on biogeochemical fluxes is enhanced by the fact that it represents the interface between the land and the ocean, whereby most of the exchanges of materials between these major biomes take place.

The littoral zone is also of key importance to society, for it is there that the interaction between humans and the ocean takes place. Maritime transport, which is the conduit for the majority of global trade, depends on ports located in the coastal zone, which also support a growing pleasure boat fleet. The littoral zone is the prime product upon which coastal tourism, one of the fastest growing industries, depends, and marine aquaculture, the fastest growing component of the primary sector, is based on the littoral zone. In addition to supporting important economic and societal activities, the littoral zone is greatly impacted by these activities, which are conducive to an important rate of ecosystem destruction and habitat modification, and is the ultimate recipient of human wastes. Hence, the littoral zone is a key component of the biosphere and of the interaction of humans with the ocean, but is, at the same time, one of the most stressed biomes on Earth.

2. The extent of the littoral zone

The coastline has a global length of about 500 000 km, and the vertical extent of the littoral zone is variable ranging down to 1 m in highly turbid estuarine waters to over 100 m in the most transparent waters, such as those in the Eastern Mediterranean. The areal extent of the littoral zone is poorly defined, due to its variable vertical extent, and probably represents about 27 km2 globally.

Estuarine waters are typically turbid, and the vertical extent of the littoral zone is, therefore, limited. In contrast, coastal waters away from river outlets in tropical and subtropical seas are often transparent and allow the growth of benthic plants down to depths in excess of 100 m.

The transparency of the water is often assessed as the maximum depth where the Secchi disc, a disc, typically 20 cm in diameter with alternate white and black quadrants, is visible. The Secchi disc depth is inversely related to the vertical light extinction coefficient (Kz, units m-1), defining the exponential reduction in irradiance with depth, according to the expression:

$$\text{Secchi disc depth (m)} = 2.6 / Kz$$

The maximum depth to which marine plants penetrate is that at which their photosynthetic carbon gains are balanced with the losses (respiration, grazing, reproduction, mechanical losses), referred to as the compensation depth. The compensation depth of seagrasses is, in general, that where 10 % of the irradiance incident in the surface penetrates, and corresponds, approximately, to the Secchi disc depth.

The thinnest macroalgae, with photosynthetic apparatus highly efficient in collecting light, can penetrate much deeper, to depths receiving as little as 0.1 % of the incident irradiance, or about three times the Secchi disc depth. Indeed, crustose macroalgae are often found at depths in excess of 100 m, whereas seagrass stands are rarely found below 40 m in even the clearest waters.

The littoral zone can be divided into the intertidal zone, where sediments are exposed directly to air at low tide, and the subtidal zone, which always remains submerged. The intertidal zone may be missing in microtidal environments (tidal range < 30 cm), such as the Mediterranean Sea, where the upper littoral zone maybe exposed to air during periods of unusually low sea level, such as during high pressure systems, and where no specific intertidal community develops.

-
-
-

Bibliography

Alongi D.M. (1998). Coastal Ecosystem Processes, 419 pp. Boca Raton, Florida, USA: CRC Press, [A textbook on coastal ecological processes, emphasizing biogeochemical fluxes in the coastal zone.]

Hemminga M. & Duarte C.M. (2000) Seagrass Ecology. Cambridge, Cambridge University Press. [An introduction to various aspects of seagrass ecology and the effects of human perturbations.]

Lobban C.S., and Harrison P.J. (1997) Seaweed Ecology and Physiology, 366 pp. Cambridge. [An introduction to the form, life cycles, physiology and ecology of seaweeds.]

Tomlinson P.B. (1986) The Botany of Mangroves. Cambridge University Press, New York, USA. [A summary of the botany and ecology of mangroves.]

Valiela I. (1977). Marine Ecological Processes. 686 pp. New York, USA: Springer [A textbook on marine ecological processes.]

Biographical Sketch

Carlos M. Duarte was born in Lisbon in 1960. He is married, and has one daughter. He completed his Ph.D. in Limnology in 1987 at McGill University (Canadá), under the supervision of Prof. J. Kalff. He later did postdoctoral work at the University of Florida (USA), and the Instituto de Ciencias del Mar (Spain). Presently, he is a Research Professor with the Spanish Council for Scientific Research at the Instituto Mediterráneo de Estudios Avanzados (IMEDEA, CSIC-UIB) in Esporles (Mallorca, Spain). He has participated in more than 40 international and national research projects, encompassing research in the Mediterranean and Atlantic Oceans, the Caribbean, SE Asia, Antarctica, and Australia. He has been a participant in dozens of scientific cruises and research campaigns and has published more than 200 papers in peer-reviewed international journals, a dozen book chapters and one book. He is a member of the editorial board of 10 journals and is co-Editor-in-Chief of the journal Estuaries. He was the recipient of the 2001 G. Evelyn Hutchinson Award of the American Society of Limnology and Oceanography. His main research interest is the ecology of littoral ecosystems and the role of the coastal ocean in the functioning of the biosphere. The research required to address this goal is necessarily interdisciplinary and encompasses population genetics, population dynamics, community ecology and ecosystems science and biogeochemistry. Throughout this research, he has focused particularly on seagrass, macroalgae and mangrove communities, as well as the functioning of littoral planktonic communities. More recently, he has been investigating the integration between the coastal and the open ocean, and has been reassessing the role of oceanic biota in the control of the global carbon cycle.