

SEAGRASS MEADOWS VITAL FOR MARINE CONSERVATION



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Seagrass meadows are often neglected in marine conservation with its high focus on coral reef protection, report **RICHARD K F UNSWORTH & LEANNE C CULLEN-UNSWORTH**. Yet seagrass perform many vital ecological functions and are very important fishing areas in the Indo-Pacific region. Their over-exploitation has serious consequences for coral reef conservation, due to inter-connected processes, fish migrations and nursery functions. Recent research highlights the value of seagrasses in mitigating climate change in a future Blue Carbon project. New marine conservation strategies must place seagrass meadows securely on the conservation programme.

Extensive evidence is documenting the sad and disastrous decline of the world's biodiverse and productive coral reefs.^{1, 2} To halt this decline, conservationists often fight a losing battle with the combined forces of global economics, climate change, corruption and limited education as they try to determine best practice methods to save these wonderful environments. Threats to seagrass meadows are less well acknowledged, yet they are key components of coastal and marine environments,¹⁶ providing some of the most economically important ecosystem services of any marine habitat.⁴ Important fisheries in their own right, they also play a significant role in the productivity of coral reefs and other fisheries. Seagrass meadows additionally support numerous charismatic faunal species, including turtle, dugong and seahorse.¹⁵

Over-exploited food source

Seagrass meadows are marine or estuarine habitats comprised of flowering plants, more closely related to terrestrial lilies than to true grasses.³ They live in

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inter-tidal and sub-tidal areas, creating habitats that can be hundreds of kilometres in length and support a plethora of rich and diverse fauna.³ Despite the recognised importance of seagrass meadows in supplying ecosystem services such as nutrient and carbon cycling, critical fish nursery habitats, coastal defence and food supply, there is growing evidence they are experiencing unprecedented levels of damage and deterioration.⁴ This destruction can almost entirely be attributed to human activities. Degradation of seagrass meadows has been commonly associated with increased nutrient run-off, sedimentation, damage from boats, other physical impacts, and pesticide leaching.⁴ However, in many areas of the world seagrass meadows are increasingly threatened by over-exploitation of their productive fish and invertebrate assemblages.⁵⁻⁷ Over-exploitation is of particular concern within the Indo-Pacific bioregion where seagrass meadows offer an easily exploitable and abundant food source for local people.

Across the Indo-Pacific as full moon approaches, the

exposed inter-tidal zone at sunset becomes a significant fishing area, with numerous fishers and families collecting invertebrates, trapping fish stranded in tide pools, or bringing in their nets laden with fish after the tide gone out. Much of this fishing is subsistence and community-based activity, but it also includes small family fishing collectives earning a basic living selling excess catch. In many locations it involves the whole family, including small children, and as a result exists as a social and recreational activity. This type of exploitation remains largely unquantified, but it can be assumed to be increasing in areas of rapid human population growth. The over-exploitation of seagrass meadows combined with other anthropogenic impacts is threatening this vastly under-appreciated resource in many regions across the Indo-Pacific.

With tropical marine conservation firmly focussed on protecting coral reef biodiversity, sadly, governments, scientists and NGOs often appear oblivious to the consequences of seagrass decline. Coral reefs are important conservation targets as iconic habitats supporting high biodiversity and productivity and providing essential ecosystem services. But their significance should be placed in the context of the sustainable long-term exploitation of the whole marine environment. An understanding of the importance of seagrass meadows through improved and widespread education is required to gain support for their conservation. Whilst development of marine protected areas has increased greatly worldwide, particularly within the Indo-Pacific region, this only includes minimal protection of seagrass meadows. In 2002 there were 247 marine protected areas containing seagrass. This is 37% of the number incorporating coral reefs,⁸ and is despite estimates suggesting global coverage of coral reefs and seagrass meadows is similar.^{8,9}

Whilst many people are aware of the importance of coral reef fisheries in tropical habitats, seagrass fisheries are often neglected. Yet seagrass meadows are ideal fishing grounds because they contain abundant fish and invertebrates, and their location in shallow water means they are easily accessible, and can usually be exploited in all weather conditions. In contrast, coral

reefs are often further from the shore and may require boat access, making them potentially inaccessible during poor weather conditions. The complex physical structure of coral reefs also makes net fishing more difficult due to the potential for net snagging. Across the Indo-Pacific, seagrass

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meadows are also commonly harvested at low tide for subsistence foodstuffs such as small molluscs, clams and urchins; and for commercial species such as octopus and sea cucumber. In some areas seagrass leaves are also directly harvested as emergency foodstuffs, or as fodder for cattle and captured turtles.

Pressures on seagrass

In Indonesia and the Philippines, seagrass beds are also under increasing pressure from hundreds of large tidal fishing nets laid for up to 100 metres across the seagrass to catch all fish moving with the tide. These tidal fishing devices fish indiscriminately, catching juveniles as well as low value species that will be discarded. The fish caught are often from families including Emperor, Rabbitfish and Parrotfish that migrate between coral reef, mangrove and seagrass habitats. Catching high numbers of Rabbitfish and Parrotfish may have long-term implications for coral reefs, as both families have been highlighted in recent research as playing important ecological roles in coral reefs, aiding reef resilience and recovery after impacts such as bleaching (damage to corals from elevated sea temperatures).^{11,12} The juvenile catch includes fish from the Grouper, Snapper and Wrasse families, commonly associated with coral reefs but utilising the abundant food sources within seagrass, their success often depends on the availability of seagrass resources.

Within Indonesia, the tidal fishing net catch from seagrass beds has been shown to experience declines of up to 60% over a five-year period, which probably reflects a similar decline in the size of the fish stock.¹³ Examination of satellite imagery across parts of Eastern Indonesia in particular illustrates the growing use of this intensive fishing method within intertidal seagrass areas which has knock-on effects for both seagrass and connected coral reef habitats.¹⁶

Invertebrate seagrass fisheries have also been found to be in decline in many areas with sea cucumber fisheries in particular commonly found to be in decline, or often stocks have already crashed. Even subsistence levels of direct invertebrate exploitation can alter and reduce the biomass and diversity within seagrasses.⁷ Commercial exploitation of seagrass fauna is common throughout the Indo-Pacific, with seagrass meadows now largely devoid of many sea cucumber species as well as the Helmet Shell (*Cassia cornuta*) which was collected for the curio trade. Seahorses are another important component of seagrass faunal species now threatened by over-exploitation.¹⁴ Four species of this delicate group of creatures are on the red list of the International Union for the Conservation of Nature as vulnerable to extinction (IUCN). But these species continue to be commonly collected throughout the Indo-Pacific and dried for use in Asian medicines.

Due to their economic and ecological importance, and the fact that seagrass meadows are becoming increasingly degraded, management of these habitats should be a major consideration when designing local marine conservation efforts. Also, for increased chances of success, coral reef conservation efforts must account for the inter-connectedness of ecosystems. Coral reefs rely on their connections with adjacent habitats for fish nursery grounds, supply of organic detritus and nutrients, and for fish and invertebrate feeding grounds.¹⁰ Effective conservation and fisheries management therefore requires a thorough understanding of resource exploitation patterns and the related impacts on all marine habitats.

Conservation and fisheries management should be as much focused on understanding socio-economic and cultural issues as on pure ecological information. Stakeholder engagement is now an accepted part of natural resource management, but to be effective, strategies need to incorporate the requirements of local people and their beliefs. Throughout the Indo-Pacific region, coastal marine habitats are culturally as well as economically important, with many traditional ways of life intricately associated with seagrass meadows for food, recreation and spiritual fulfilment. The *Bajo* for example are a landless people who live in a physical landscape dominated by sea and islands.

They were traditionally nomadic living in small family units on boats. During the 20th century, however, the vast majority of the *Bajo* were forced to settle, creating large communities living in houses built on stilts in inter-tidal areas covered largely by seagrass. Many *Bajo* still live in this way across the Indo-Pacific, and communities increasingly depend on declining marine resources.

In a world of changing climate, with exponential consumption in the developed world, increasing population growth in the developing world, plus mass extinctions of biodiversity through large-scale habitat loss, governments, NGOs, communities and conservation bodies involved in marine conservation have to prioritise natural resource management activities. The circumstances within which environmental management decisions are made are often difficult, and decisions have often been made based on quite limited information. With increased education of the value of seagrass meadows, such decisions needn't be based on a scarcity of information.

Another factor making tropical seagrass meadows vital for marine conservation is that they contain some physiological characteristics which may make them better placed to adapt to global climate change than other tropical marine habitats.^{16,17} Coral reefs, for example, are predicted to decline due to rising sea temperatures, ocean acidification, and increased industrialisation. The value of the ecosystem services that seagrass meadows provide for humanity may be much higher than those of coral reefs, largely as a result of their nutrient cycling capacity that arguably stimulates fisheries production.⁴

Recent research also highlights the value of seagrasses in mitigating climate change and their potential to offset emissions globally through a future 'Blue Carbon' mechanism.¹⁹ Therefore, although developing world economics are often at odds with the vision of developed world conservation ethics, conserving seagrass meadows may be not only an important long-term approach to biodiversity conservation and food security, but also a means to create income to support conservation and mitigate climate change. In a world that is reaching peak oil, and where developing nations of the Indo-Pacific are reportedly feeling the force of high fuel and food prices more than others, conservation mechanisms that integrate food security planning and economic development together with environmental management are vital.

Holistic approach needed

Marine conservation efforts are often guided by scientists absorbed in their own ecological interests, current scientific trends; and misguided funding priori-

ties. As a result, marine conservation remains largely a uni-disciplinary task with little inter-disciplinary action. This can result in a flawed understanding of ecology and the needs of stakeholders. It is critical for marine conservation to take a more holistic approach, and for scientists to look beyond their own disciplines and areas of interest to provide the best advice. A broader over-arching ecosystem-based approach to managing natural resources is required, incorporating good inter-disciplinary, multifaceted science. Yet many developing nations lack the political, economic, legal or social management capacity. An encouraging development is the 'ridge to reef' type strategies being taken by some NGOs in the Indo-Pacific, which consider river catchments and lagoon habitats like seagrass as important components of coral reef conservation. Seagrass meadows throughout the Indo-Pacific are highly important fishing areas in their own right but their over-exploitation has implications not just for seagrass meadows, but also for coral reef conservation, due to inter-connected processes, mainly fish migrations and nursery functions.

While the majority of floral seagrass species are not currently at risk and are common, the habitats they create are being lost at a rate of 7% annually,¹⁸ and the ecosystem services they provide are also being lost. Specifically within South-East Asia, the extent of estimated loss during the past 50 years is greater than 50% in some areas.²⁰ This has serious consequences for ecologically rare species residing in seagrass or those which are vulnerable to extinction.¹⁵ From an Indo-Pacific coral reef perspective, seagrass loss should be of concern as seagrass meadows not only support fisheries and biodiversity directly and indirectly, they also act as biological filters, a critical role in a region experiencing increasing sedimentation and nutrient run-off from increasing deforestation, agriculture and urbanisation.

Seagrass meadows are not always an aesthetically pleasing habitat. They can be muddy, turbid water environments which don't immediately impress in magazines as colourful, biodiverse wonders of the world. But these uncharismatic ecosystems do support IUCN Red List 'threatened' species and are undoubtedly important economic and ecological resources which vitally need conserving.¹⁶ Indo-Pacific seagrass meadows provide many ecosystem goods and services, directly and through their supporting role to coral reefs. The recent recognition of seagrasses in the framework for a future 'Blue Carbon' mechanism

adds to their global value. And importantly seagrasses are a source of food security in a rapidly changing global environment. Despite this seagrass meadows are experiencing unprecedented rates of loss and growing over-exploitation. These issues must be addressed by adopting new marine conservation strategies across the Indo-Pacific which place seagrass meadows securely on the conservation programme.

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REFERENCES

- Pandolfi JM, Bradbury RH, Sala E, Hughes TP, Bjorndal KA, Cooke RG, McArdle D, McClenachan L, Newman MJ, Paredes G, Warner RR, Jackson JB (2003) Global trajectories of the long-term decline of coral reef ecosystems. *Science* 301: 955-958
- Bellwood DR, Hughes TP, Folke C, Nystrom M (2004) Confronting the coral reef crisis. *Nature* 429: 827-833
- Hemminga MA, Duarte CM (2000) *Seagrass Ecology*. Cambridge University Press.
- Orth RJ, Carruthers TJB, Dennison WC, Duarte CM, Fourqurean JW, Heck Jr, KL, Hughes AR, Kendrick GA, Kenworthy WJ, Olyarnik S, Short FT, Waycott M, Williams SL (2006) A global crisis for seagrass ecosystems. *Bioscience* 56: 978-996
- Fortes MD (1990) Seagrasses: A resource unknown in the ASEAN Region. ICLARM Education Series 5, No. 46. International Centre for Aquatic Living Resources, Manila, Philippines, 46 pp
- Tomaschik T, Mah JA, Nontji A, Moosa KM (1997) *The Ecology of the Indonesian Seas (Part II)*. Periplus Editions (HK) Ltd, University of Oxford Press
- Nordlund L (2006) Human impact on invertebrate abundance, biomass and community structure in seagrass meadows - a case study at Inhaca Island, Mozambique. *Minor Field Studies* No 341 Swedish University of Agricultural Sciences ISSN 1402-3237
- Spalding MD, Taylor ML, Ravilious C, Short FT, Green EP (2003). The global distribution and status of seagrass ecosystems. In Green EP and Short FT (eds.) *World Atlas of Seagrasses*. University of California Press, Berkeley, USA.
- Spalding MD, Grenfell AM (1997). New estimates of global and regional coral reef areas. *Coral Reefs* 16: 225-230.
- Harborne AR, Mumby PJ, Brumbaugh D, Micheli F, Holmes K, Perry C, Dahlgren C (2006) Functions of Caribbean coral reef, seagrass and mangrove habitats. *Advances in Marine Biology* 50: 57-190
- Fox RJ, Bellwood DR (2008) Remote video bioassays reveal the potential feeding impact of the rabbitfish *Siganus canaliculatus* (F. Siganidae) on an inner shelf reef of the Great Barrier Reef. *Coral Reefs* DOI 10.1007/s00338-008-0359-6
- Mumby PJ, Hastings A, Edwards HJ (2007) Thresholds and the resilience of Caribbean coral reefs. *Nature* 450: 98-101
- Exton, D.A. (2010) Nearshore fisheries of the Wakatobi. Pages 89-111 in J. Clifton, R.K.F. Unsworth, editors. *Marine conservation and research in the Coral Triangle: the Wakatobi Marine National Park*. Nova Scientific, New York. ISBN 9781616684730.
- Curtis JMR, Ribeiro J, Erzini K, Vincent ACJ (2007) A conservation trade-off? Interspecific differences in seahorse responses to experimental changes in fishing effort. *Aquatic Conservation: Marine And Freshwater Ecosystems* 17: 468-484
- Hughes, A.R., Williams, S.L., Duarte, C.M., Heck, K.L., Waycott, M. (2009). Associations of concern: declining seagrasses and threatened dependent species. *Front Ecol Environ*, 7, 242-246.
- Unsworth RKF, Cullen LC (2010) Recognising the Necessity for Seagrass Conservation. *Conservation Letters*, 3 (2): 63-73.
- Hall-Spencer, J.M., Rodolfo-Metalpa, R., Martin, S., Ransome, E., Fine, M., Turner, S.M., Rowley, S.J., Tedesco, D., Buia, M.C. (2008). Volcanic carbon dioxide vents show ecosystem effects of ocean acidification. *Nature*, 454, 96-99.
- Waycott, M., Duarte, C.M., Carruthers, T., Orth, J.J., Dennison, W.C., Olyarnik, S., Calladine, A., Fourqurean, J.W., Heck, K.L., Hughes, R., Kendrick, G.A., Kenworthy, W.J., Short, F., Williams, S.L. (2009). Accelerating loss of seagrasses across the globe threatens coastal ecosystems. *Proceedings of the National Academy of Science USA*, 106, 12377-12381.
- Kennedy, H., and M. Björk (2009) Seagrasses, in *The Management of Natural Coastal Carbon Sinks in Coastal Ecosystems: Investigating and Realising the Potential*, edited by D. de Laffoley and G. Grimsditch, 609 pp. 23-30, IUCN, Gland, Switzerland.
- Kirkman, H., Kirkman, J.A. (2002). The management of seagrasses in Southeast Asia. *Bulletin of Marine Science*, 71, 1379-1390.

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