

2011, Ling et al. 2015; Rocha et al., 2015; Russell and Connell 2014; Steneck et al., 2013.

Apart from overexploitation, kelp population and distribution worldwide are reported to be affected by a variety of factors. Connell et al. (2008) reported wholesale loss of canopy-forming kelp forests (up to 70 per cent) on the Adelaide metropolitan coast of South Australia where urbanization occurred. Overfishing of high value predators often causes explosions in herbivore populations such as sea urchins that feed on kelps, resulting in

populations five species seven

Furthermore, the loss of seagrass beds and kelp forests will deprive commercially

References

- Baldwin, J.R., Lovvorn, J.R. (1994). Expansion of seagrass habitat by the exotic *Zostera japonica*, and its use by dabbling ducks and brant in Boundary Bay, British Columbia. *Marine Progress Series* 13: 119-127.
- Barbier, E.B., Georgiou, I.Y., Enchelmeyer, B., Reed, D.J. (2013). The Value of Wetlands in Protecting Southeast Louisiana from Hurricane Storm Surge. *PLoS ONE* 8(3): e58715. doi:10.1371/journal.pone.0058715.
- Barbier, E.B., Hacker, S.D., Kennedy, C., Koch, E.W., Stier, A.C., Silliman, B.R. (2011). The value of estuarine and coastal ecosystems. *Ecological Monographs* 81(2): 169-199.

- theories and the assessment of species vulnerability to global change in temperate estuaries. *Estuarine, Coastal and Shelf Science* 52:63.
- Connell, S., Russel, B., Turner, D., Shepherd, S., Kildea, T., Miller, D., Airoldi, L., Cheshire, A. (2008). Recovering a lost baseline: missing kelp forests from a metropolitan coast. *Marine Ecology Progress Series* 360: 6372.
- Connell, S.D., Russel, B.D., Irving, A.D. (2011) Can strong consumer and producer effects be reconciled to better forecast catastrophic shifts in marine ecosystems? *Journal of Experimental Marine Biology and Ecology* 400, 296-301.
- Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., van den Belt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature* 387: 253-260.
- Cullen-Unsworth, L.C., Nordlund, L.M., Paddock, J., McKenzie, L.J., Unsworth, R.K.F., Baker, S. (2014). Seagrass meadows globally as a coupled ecological system: Implications for human wellbeing. *Marine Pollution Bulletin* 83(2): 387-97. doi: 10.1016/j.marpolbul.2013.06.001.
- Dayton, P.K. (1985). Ecology of kelp communities. *Annual Review Ecology Systems* 16: 215-245.
- Dayton, P.K., Tegner, M.J., Edwards, R., Berger, K.L. (1999). Temporal and spatial scales of kelp demography: the role of oceanography, climate. *Ecological Monographs* 69: 219-250.
- Den Hartog, C. (1970). The Seagrasses of the World. Amsteraa9 /T2(t)-1 1 Tf - i3 Tf7tlun, of-19.7elp (B)5, ili4(h)ein8(f)]TJ 4Mlbcoll]T13I15atepial(e)3 -0.5-5(4 TI9604(4))-3(i/TT1 ut(m)14(u

Eckman, J.E., Duggins, D.O., Siddon, C. (2003) Current and wave dynamics in the shallow subtidal: implications to the ecology of understory and surface kelps. *Marine Ecology Progress Series* 265, 4556.

Estes, J.A., Terborgh, J., Brashares, J.S., Power, M.E., Berger, J., Bond, W.J.,

- Millar, A.J.K. (2007). The Flindersian and Peronian Provinces. McCarthy, P., Orchard,A., (Eds.). Algae of Australia. An Introduction. CSIRO Publishing, Melbourne, pp. 554559.
- Moncreiff, C.A.Sullivan, M.J.(2001) Trophic importance of epiphytic algae in subtropical seagrass beds: evidence from multiple stable isotope analyses. *Marine Ecology Progress Series* 215, 93106.
- Moy, F., Christie, H. (2012). Large scale shift from sugar kelp (*Saccharina latissima*) to ephemeral algae along the south and west coast of Norway. *Marine Biology Research* 8: 309321.
- Müller, R., Laepple, T., Bartsch, I., Wiencke, C. (2009). Impact of oceanic warming on the distribution of seaweeds in polar and temperate waters. *Botanica Marina* 52:617-638.doi 10.1515/bot.2009.080.
- Nelleman, C., Corcoran, E., Duarte, C.M., Valdes, M., DeYoung, C., Fonseca, L., Grimsditch, G., Eds. (2009). Blue Carbon: A Rapid Response Assessment. United Nations Environmental Programme GRID Arendal. www.grid.no
- Orth, R.J., Carruthers, T.J., Dennison, W.C., Duarte, C.M., Fourqurean, J.W., Heck, K.L.Jr., Hughes, A.R., Kendrick, G.A., Kenworthy, W.J., Olyarnik, S., Short, F.T., Waycott, M., Williams, S.L. (2006) A global crisis for seagrass ecosystems. *BioScience* 56(12):987-996.
- Pergent, G., Semroud, R., Djellouli, A., Langar, H., Duarte, C.M. (2010) *Posidonia oceanica*. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 5 May 2015.
- Pereira, T., Engelen, A., Pearson, G., Serrão, E., Destombe, C., Valero, M. (2011).

- Robertson, A.I., Mann, K.H. (1980). The role of amphipods and isopods in the initial fragmentation of eelgrass detritus in Nova Scotia, Canada. *Marine Biology* 59:63-69.
- Robinson, T. (2011) Connemara a little Gaelic Kingdom Dublin: Penguin, Ireland.
- Rocha, J., Yletyinen, J., Biggs, R., Blenckner, P., Peterson, G. (2015). Marine regime shifts: drivers and impacts on ecosystems services. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 370(1659), 20130273. 10.1098/rstb.2013.0273.
- Roleda, M.Y., Morris, J.N., McGraw, C.M., Hurd, C.L. (2012). Ocean acidification and seaweed reproduction: increased CO₂ ameliorates the negative effect of lowered pH on meiospore germination in the giant kelp *Macrocystis pyrifera* (Laminariales, Phaeophyceae). *Global Change Biology* 18, 854-864.
- Russell, B., Connell, S. (2014) Ecosystem resilience and resistance to climate change. *Global Environmental Change* 31:133-139.
- Russell, B., Thomsen, M., Gurgel, F., Bradshaw, C., Poloczanska, E., Connell, S. (2011). Seaweed communities in retreat from Ocean Warming. *Current Biology* 21:1828-1832.
- Short, F.T., Carruthers, T.J., Dennison, W.C., Waycott, M. (2007) Global seagrass distribution and diversity: a bioregional model. *Journal of Experimental Marine Biology and Ecology* 350:3-20.
- Short, F.T., Mathieson, A.C., Nelson, J. (1986) Recurrence of the eelgrass wasting disease at the border of New Hampshire and Maine, USA. *Marine Ecology Progress Series* 29, 89-92.
- Short, F.T., Polidoro, B., Livingstone, S.R., Carpenter, K.E., Bujang, J.S., Calumpong, H.P., Carruthers, T.J.B., Coles, R.G., Bandeira, S., Dennison, W.G., Erftemeijer, P.L.A., Fortes, M.D., Freeman, A.S., Jagtap, T.G., Kamal, M.A.K., Kendrick, G.A., Kenworthy, W.J., La Nafie, Y.A., Nasution, I.M., Prathee, A., Sanciangco, J.C., van Tussenbroek, B., Vergara, S.G., Waycott, M., Zieman, J.C., Orth, R.J. (2011). Extinction risk assessment of the world's seagrass species. *Biological Conservation* 144: 1961-1971.
- Smale, D.A., Wernberg, T. (2013). Extreme climatic event drives range contraction of a habitat-forming species. *Proceedings of the Royal Society Biological Sciences* 280: 20122829.
- Steneck, R., Graham, M., Bourque, B., Corbett, D., Erlandson, J., Estes, J.A., Tegner, M.J. (2002). Kelp Forest Ecosystems: Biodiversity, Stability, Resilience and Future. *Environmental Conservation* 29 (4): 436-459.
- Steneck, R.S., Leland, A., Mcnaught, D.C., Vavrinec, J. (2013) Ecosystem Flips, Locks, and Feedbacks: the Lasting Effects of Fisheries on Maine's Kelp Forest Ecosystem. *Bulletin of Marine Science* 89:31-55. <http://dx.doi.org/10.5343/bms.2011.1148>.

- Stephenson, W.A. (1968). Seaweed in Agriculture and Horticulture. Faber and Faber: London, 231 pp
- Strain E.M.A., Thomson, R.J., Micheli, F., Mancuso (2014). Identifying the interacting roles of stressors in driving the global loss of canopy-forming to mat-forming algae in marine ecosystems. *Global Change Biology* 20(11) 3300-3312.
- Suchanek, T.H., Williams, S.L., Ogden, J.C., Hubbard, D.K., Gill, I.P. (1985). Utilization of shallowwater seagrass detritus by Caribbean deep macrofauna: ^{13}C evidence. *Deep Sea Research* 32(2): 201-214.
- Tegner M.J., Dayton, P.K. (2000)

Wood, E.J., Odum, W.E., Zeiman, J. (1969) Influence of Seagrasses on the Productivity of Coastal Lagoons. Universidad Nacional Autónoma de México: Mexico, pp. 495-502.