

## ***Interactive comment on “Dynamics of environmental conditions during a decline of a *Cymodocea nodosa* meadow” by Mirjana Najdek et al.***

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We greatly appreciate all the reviewers' comments and suggestions. Please find our response letter below. Interactive comment on “Dynamics of environmental conditions during a decline of a *Cymodocea nodosa* meadow” by Mirjana Najdek et al. Anonymous Referee #1 Received and published: 1 February 2020 The authors investigated the dynamics of environmental conditions during a decline of a *Cymodocea nodosa* meadow in the northern Adriatic Sea, analyzed the correlation between those physicochemical and biological parameters, and concluded that the reduced light availability and following photosynthesis was the most likely reason leading to the decay of sea-

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grass meadow. The experiments seem to be conducted carefully and the results were thoroughly discussed. This study supplies helpful information on understanding the decline of seagrass globally. However, there are some points that the authors need to attend to before it can be published in Biogeosciences. I have two general concerns about this study. 1. The loss of seagrass meadow is attributed to reduced light availability and thus photosynthesis in this study. However, it seems that there is no direct data to support this conclusion. Have the light intensity in water column and photosynthetic rate of seagrasses were measured? The solar radiation in April should not be the lowest level compared to other months. 2. The authors mentioned that from July 2017 to March 2018, *C. nodosa* successfully adapted to the changes of environmental conditions and prevented H<sub>2</sub>S accumulation by its re-oxidation, supplying the sediment with O<sub>2</sub> from the water column and/or leaf photosynthesis. Then why did not *C. nodosa* adapt to the environmental changes from April 2018 onwards? I am wondering that the decline of seagrass meadow in the northern Adriatic Sea is a natural process or caused by other drivers?

Authors response: Light intensity in the water column and photosynthetic rates of seagrass were not measured. The reduction of available light to the *C. nodosa* meadow in April 2018 was indicated by a visible increase in turbidity of the water column (noted in situ by divers), due to an increased concentration of particulate matter of terrigenous origin and sediment resuspension. Terrigenous input in combination with sediment resuspension covered the plant with sediment; thereby significantly reducing the amount of light to the plant below the minimum required for photosynthesis. Besides reduced photosynthesis and therefore supply of the below-ground tissue with oxygen, a depletion of oxygen due to intense oxidation of H<sub>2</sub>S occurred in the sediment, thus creating anoxic conditions in most of the rooted areas. Most likely, this change in April 2018 drastically and irreversibly compromised the survival of the meadow. From April 2018 onwards, *C. nodosa* didn't reestablish photosynthesis and continued to lose shoots and overall biomass, while at the same time in the sediment, the concentration of H<sub>2</sub>S increased considerably, which, due to lack of oxygen, penetrated the plant and caused

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the meadow die-off. We would exclude that the process in Saline Bay was natural because several geographically nearby meadows didn't display a similar pattern of regression.

Specific comments: Line 22 Why did light availability decrease in April 2018? Authors response: This sentence in the Abstract was rewritten and now reads: The *C. nodosa* decline was most likely triggered in April 2018 when light availability to the plant was drastically reduced. Such conditions resulted from increased seawater turbidity due to terrigenous input, sediment resuspension and elevated autotrophic biomass.

Line 30 The data in Figure 2 did not show the recovery of the below-ground tissue. Authors response: We agree with this comment. The sentence in the Abstract now reads: The influx of oxygenated waters in September 2018 led to the re-establishment of H<sub>2</sub>S oxidation in the sediment and the remaining of the below-ground tissue.

Line 37 Better to supply latest literature as there are loads. Authors response: The following literature has been added. . . e.g. Duarte et al., 2013, Samper-Villarreal et al., 2016

Line 41 Add a comma after matter. . . a comma was added

Line 85 A introduction about seagrass meadows in Saline Bay or Adriatic Sea should be supplied here. Meanwhile, it would be helpful to add research gap here. Authors response: Introduction about seagrass meadows in Adriatic and research gap was added. This paragraph now reads: The seagrass *Cymodocea nodosa* (Ucria) Ascheron is widely distributed and common species throughout the Mediterranean (Terrados and Ros 1992; Pedersen et al., 1997; Cancemi et al., 2002; Agostini et al., 2003). For the northern Adriatic, however, only sparse data are available on the standing crop, seasonal dynamics or natural/anthropogenic pressures supporting the ecological or conservation status of *C. nodosa* meadows (Zavodnik et al., 1998; Orlando-Bonaca et al., 2015; 2016). Although *C. nodosa* show large phenotypic plasticity adapting to diverse natural and anthropogenic stressors by physiological and morphological adap-

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tations, a severe decline has been reported during the last decades in coastal areas (Orth et al., 2006; Short et al., 2011; Tuya et al., 2002; 2014), including the northern Adriatic (Orlando-Bonaca et al., 2015; 2019). One of these declines is documented in our study performed in Saline Bay (northern Adriatic Sea) from July 2017 to October 2018.

Line 98 Better to supply a map for the study site. A map is now provided as Fig S1.

Line 116 Sampling time/frequency needs to be stated. What is the depth for *C. nodosa* living? Authors response. The sampling dates and depths of *C. nodosa* were included and now reads: The sampling was performed for 15 months from July 2017 to October 2018. *C. nodosa* (3 - 4 m of depth) was collected together with rhizomes, roots and macroalgae by divers using the quadrat sampling method.

Line 320 This is true as shown in the green macroalgae *Ulva linza* (Gao et al. 2018 Food Chemistry, 2018, 258: 71-78). Authors response: The suggested reference was added in the text and listed in References

Line 386 What are these prokaryotic organism? Authors response: Prokaryotic organisms are Bacteria and Archaea from 0.2 – 2  $\mu$ m, stained with DAPI and counted by epifluorescence microscopy.

Lines 485-487 How did you know it? Any data or literature to support this speculation? Authors response: In July and August 2017 the leaves were short with visible signs of bites, so we assumed that significantly lower biomass in these two months was the result of grazing activity of herbivores. Generally, the meadows have been shown to be an important source of food for herbivores. We have added the references that support biomass loss by herbivory in *C. nodosa* meadows; Cebrian et al., 1996; Valentine and Duffy, 2006.

Line 680 Conclusion should not be a repetition of Abstract. The purpose of a conclusion is to tie together, or integrate the various issues, findings, arguments etc., covered

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in the body of the paper, and to make comments upon the meaning of all of it. This includes noting any implications resulting from your discussion of the topic, as well as recommendations, forecasting future trends, and the need for further research. Authors response: The Conclusion has been rewritten and now reads: Our results provide insights into the interaction of multiple stressors that have led to the meadow decay, triggered in the sensitive recruitment phase of meadow growth. Even after the improvement of the sediment conditions by the end of the summer 2018, *C. nodosa* was not able to recolonize its previously occupied areas. This finding combined with a visible alteration of the water column and sediment indicates a considerable loss of the *C. nodosa* habitat. Further research is needed to examine the fate of Saline Bay meadows and an eventual recolonization of the area. Beyond seagrass itself, this loss had extensive consequences as it has endangered many species that depend on seagrass for food, shelter and nursery. Given the lack of data on the ecological and conservation status of the still numerous seagrass meadows along the northern Adriatic coast, the identification and monitoring of the main pressures acting on them are needed to protect such valuable habitats from degradation and extinction.

Line 950 Please annotate which year for the months and explain why it ends in Feb in the legends. Authors response: The years are annotated and an explanation is added in the Figure 4 legend which now reads: Figure 4. The contribution of macroalgal phyla in a meadow and total macroalgal biomass; after February 2018 macroalgae were no longer present in the *C. nodosa* meadow.

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