

EVIDENCE OF ANCHOR EFFECT IN A *POSIDONIA OCEANICA* SEAGRASS MEADOW UNDER LOW ANCHORING PRESSURE VIA A MULTI-CRITERIA GRID

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Abstract

An index (MCAI: Multi-Criteria Anchoring Index) based upon nine parameters and their weighting is proposed. It evidences the effect of anchoring on the *Posidonia oceanica* seagrass meadow, even under relatively low mooring pressure.

Keywords: *Posidonia*, Monitoring, North-Western Mediterranean

Introduction

Posidonia oceanica is a Mediterranean seagrass that is sensitive to a variety of anthropogenic disturbances and stress, among them anchoring. The impact of large boats, e.g. cruise ships, is obvious [1,2]. As far as small pleasure boats are concerned, the maximum sustainable mooring pressure on *P. oceanica* meadows has been suggested to be two anchorage events $\text{ha}^{-1} \text{d}^{-1}$ (annual average), the number of anchoring boats never exceeding 10 ha^{-1} for a given day [3]. Higher anchoring pressure would result in meadow regression. In contrast, under low mooring pressure, the effect of anchors proved to be more or less unclear, whenever the proxies of anchoring pressure were considered separately.

Material and methods

Six sites within the Port-Cros National Park (Provence, France, northwestern Mediterranean Sea), 7 to 9 m depth, were studied in 2011. Mooring has been banned at Site 2 (East Bagaud Island) since 1993 and Site 6 (Pointe Nord) since 2002. Anchoring pressure is very low in summer at Site 1 (East Bagaud Island: 0.08 boat $\text{ha}^{-1} \text{d}^{-1}$). It is relatively low at Site 3 (Saint-Pierre Cove: 0.12 boat $\text{ha}^{-1} \text{d}^{-1}$), Site 4 (Fausse Monnaie Cove: 0.13 boat $\text{ha}^{-1} \text{d}^{-1}$) and Site 5 (Pomme d'Or Point: 0.13 boat $\text{ha}^{-1} \text{d}^{-1}$) [4]. Parameters taken into account were: (i) *P. oceanica* percent cover, (ii) shoot density, (iii) bared rhizomes, (iv) % of plagiotropic (i.e. creeping) rhizomes, (v) number of free uprooted and broken shoots, (vi) compactness of the mat, (vii) fragmentation of the meadow, (viii) density of living individuals of the noble pen shell *Pinna nobilis* and (ix) ratio between living and dead or broken *P. nobilis* shells. Parameters (v), (viii) and (ix) are innovative.

Tab. 1. Multi-criteria grid of *P. oceanica* meadow parameters (i through ix), parameter marks (0 through 2) and parameter weighting (1 through 3). Study sites are ranked from absence of mooring (left: 2 and 6) to highest anchoring pressure (right: 4 and 5). In each box: the product of mark and weighting. White = normal status, light grey = intermediate status, dark grey = abnormal status. MCAI = overall mark for a given site.

Parameter	Weight	Site 2	Site 6	Site 1	Site 3	Site 4	Site 5
i	3	2 x 3 = 6	2 x 3 = 6	1 x 3 = 3	1 x 3 = 3	1 x 3 = 3	0 x 3 = 0
ii	2	1 x 2 = 2	1 x 2 = 2	2 x 2 = 4	1 x 2 = 2	1 x 2 = 2	0 x 2 = 0
iii	1	1 x 1 = 1	1 x 1 = 1	2 x 1 = 2	1 x 1 = 1	1 x 1 = 1	2 x 1 = 2
iv	2	2 x 2 = 4	2 x 2 = 4	1 x 2 = 2	1 x 2 = 2	2 x 2 = 4	2 x 2 = 4
v	3	2 x 3 = 6	2 x 3 = 6	0 x 3 = 0	0 x 3 = 0	0 x 3 = 0	0 x 3 = 0
vi	2	2 x 2 = 4	1 x 2 = 2	2 x 2 = 4	2 x 2 = 4	1 x 2 = 2	1 x 2 = 2
vii	1	2 x 1 = 2	2 x 1 = 2	2 x 1 = 2	2 x 1 = 2	2 x 1 = 2	1 x 1 = 1
viii	1	2 x 1 = 2	2 x 1 = 2	2 x 1 = 2	1 x 1 = 1	2 x 1 = 2	1 x 1 = 1
ix	3	1 x 3 = 3	2 x 3 = 6	2 x 3 = 6	1 x 3 = 3	1 x 3 = 3	0 x 3 = 0
MCAI		30	31	25	18	19	10

Results and discussion

For each parameter (i through ix), at each site (1 through 6), a mark was assigned, based on [3, 5] and field observations: 0 = abnormal, 1 = intermediate and 2 = normal. A few parameters were correlated with the anchoring pressure (i, v and vii), while most of them were not clearly correlated (Table 1). However, the 9 parameters considered are of strongly contrasted importance: percent cover, number of broken shoots and ratio between living and broken *Pinna nobilis* shells matter more than e.g. bared rhizomes and compactness of the mat. Parameters were therefore weighted (1 through 3). For each parameter at each site, the site mark was the product of parameter mark and parameter weight. The overall mark (MCAI: Multi-Criteria Anchoring Index)

for a given site was the sum of the nine site marks (Table 1). For more details, see [6]. While individual parameters give contrasted responses, if any, to low mooring pressure, the multi-criteria response (overall mark, MCAI; Table 1) unequivocally evidences, for the first time, the expected response of the seagrass meadow. However, it is worth noting that the evidence of an effect does not mean that it is beyond the resilience of the meadow: for example, the annual production of new shoots (via rhizome branching) can compensate shoot breakage (by anchors).

References

- 1 - Boudouresque C.F., Bernard G., Pergent G., Shili A. and Verlaque M., 2009. Regression of Mediterranean seagrasses caused by natural processes and anthropogenic disturbances and stress: a critical review. *Bot. Mar.*, 52: 395-418.
- 2 - Ganteaume A., Bonhomme P., Emery E., Hervé G. and Boudouresque C.F., 2005. Impact sur la prairie à *Posidonia oceanica* de l'amarrage des bateaux de croisière, au large du port de Porquerolles (Provence, France, Méditerranée). *Sci. Rep. Port-Cros natl Park*, 21: 163-173.
- 3 - Boudouresque C.F., Bernard G., Bonhomme P., Charbonnel E., Diviacco G., Meinesz A., Pergent G., Pergent-Martini C., Ruitton S. and Tunesi L., 2012. Protection and conservation of *Posidonia oceanica* meadows. RAMOGE, Monaco, RAC/SPA, Tunis and Gis Posidonie, Marseille, publ.: 202 pp.
- 4 - Bountifles Port-Cros, 2010. Récapitulatif du suivi de la fréquentation touristique en 2010. www.documents.com.co/-2010+bountifles+port+cros. Consulté en Novembre 2012.
- 5 - García-March J.R., García-Carrascosa A.M., Peña Cantero A.L. and Wang Y.G., 2007. Population structure, mortality and growth of *Pinna nobilis* Linnaeus, 1758 (Mollusca, Bivalvia) at different depths in Moraira bay (Alicante, Western Mediterranean). *Mar. Biol.*, 150: 861-871.
- 6 - Rouanet E., Astruch P., Bonhomme D., Bonhomme P., Rogeau E., De Saint Martin T. and Boudouresque C.F., 2012. Suivi de l'herbier de posidonie de la passe de Bagaud, impact de l'ancrage (Parc national de Port-Cros, Var, France). Parc national de Port-Cros and GIS Posidonie, GIS Posidonie publ., Marseille: 82 pp.