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REVIEW ARTICLE

A review on *Posidonia oceanica* (Linnaeus) Delile coverage along the Turkish coasts until 2019

Barış Akçalı*, Gökhan Kaboğlu, Harun Güçlüsoy

Institute of Marine Sciences and Technology, Dokuz Eylül University, İzmir, TURKEY

***Corresponding author:** baris.akcali@deu.edu.tr

Abstract

Mapping benthic habitats is an essential, actually a *sine qua non*, tool for marine spatial planning and management. *Posidonia oceanica* (Linnaeus) Delile is an important endemic seagrass species in the Mediterranean Sea. In this study, all mapping efforts along the Turkish coasts have been reviewed through the publications and summarized including locations and coverage information. Consequently, a total of 14 486.20 ha of *P. oceanica* coverage was reported in 16 studies until 2019. However, this figure seems to be remarkably underestimated. It is therefore determined that the mapping of *Posidonia* seagrass beds in Turkey has not yet provided exploitable information and data for marine spatial planning and still remains as an urgent task.

Keywords: Habitat mapping, *Posidonia oceanica*, Mediterranean Sea, Sea of Marmara

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Habitat mapping is an important tool in marine spatial planning and coastal management for marine resources (Piazzi *et al*. 2000; Kostylev *et al*. 2001; Baker and Harris 2012), as a *sine qua non* requirement. Conservation and monitoring activities cannot be designed and/or applied unless such information on coastal/marine habitats are available. Thus, it is essential to have knowledge on the geographical distribution of coastal/marine habitats.

Posidonia oceanica (Linnaeus) Delile is an endemic seagrass species, which spreads over the infralittoral zone (1-40 m) in the Mediterranean Sea. It can form extensively large meadows that play important ecological (spawning areas, nursery, primary production, oxygenation, sediment fixation, *etc*.), and economical roles (prevent erosion of coastal line, creating nursery ground for fish stocks, *etc*.) for marine and coastal systems (Bell and Harmelin-Vivien 1983; Duarte 2002; Pergent 2006; Boudouresque *et al.* 2016). Besides, *P. oceanica*, as a species, is an efficient biological indicator for estimating the state

of coastal marine ecosystems (Pergent 1991b; Pergent *et al.* 1995; Pergent-Martini and Pergent 2000; Ruiz and Romero 2003).

Overall coverage of seagrass beds throughout the world are declining due to impacts of climate change and adverse anthropogenic activities (Short and Willie-Echevarria 1996; Procaccini *et al.* 2003; Boudouresque *et al.* 2009). The level of decline has reached a critical point that *P. oceanica* has been listed in the Annex II of "Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean" within the framework of the Barcelona Convention (Protocol SPA 1995). It is also under the protection of European Union's Habitat Directive (92/43/CEE) which comprises *P. oceanica* beds are among priority habitats (Habitat Type 1120: *P. oceanica* beds) (Pergent 1991a; Boudouresque 2013; Boudouresque and Bianchi 2013; EC 2007). Moreover, Turkey has its own national legislations about the protection of *P. oceanica* under the professional (4/1) and recreational (4/2) Fisheries Circulars (Anonymous 2016 a, b) as a party to Barcelona Convention. Following these developments, the importance of having precise data and information on the distribution, coverage and state of health of *P. oceanica* meadows has been acknowledged as essential to assess the management plans/activities to be carried out for protection and monitoring.

In Turkish seas, the mapping efforts of *P. oceanica* meadows began in 1985. After two decades of cessation period, they started to regain a progressive pace in 2003 and are currently continuing. The distribution of *P. oceanica* along the Turkish coastline was estimated by Telesca *et al.* (2015) as 287 ha. Evidently, this figure was not complete, since it does not contain relevant literature published in Turkish.

The purpose of this study is to provide more complete up-to-date review and collation of all available data in order to present more reliable revision on the coverage of *P. oceanica* habitats in the Turkish seas. To fulfill the intended purpose, all available literature including published and/or gray were carefully searched and the ones containing the information on distribution properties were included and exploited. Data from these publications were compiled and given in Table 1 and Figure 1. In addition, geographically overlapped coverage information were corrected and adjusted in a manner that the information on the larger geographical area is preserved.

The data set of the study is based on a total of 20 studies on the mapping of *P. oceanica* meadows in the Turkish coasts. Four of these studies (Pergent *et al.* 2013; Mutlu *et al.* 2014; Duman *et al.* 2018) provide the information on the distribution without any coverage figures. Five of these studies (Pergent and Pergent 1985; Dural *et al.* 2013; Akçalı *et al.* 2019; Akçalı *et al.* 2010; Yücel-

Gier *et al.* 2019) were carried out in the İzmir Bay, but the area studied by Dural *et al.* (2013) encompasses the other four studies. Therefore, the results given by only Dural *et al.* (2013) were taken into account for the *P. oceanica* coverage in the İzmir Bay. Moreover, it is worth noting that Duman *et al.* (2018) had provided coverage estimations on seagrasses without emphasizing species-specific properties. Finally, a total of 14 486.20 ha was estimated for *P. oceanica* meadows coverage area on the 26 locations along the Turkish coasts from data produced between 1985 to 2019.

Table 1. The chronological list of *P. oceanica* coverage figures until 2019

#	Date*	Location**	Area (ha)	References
1	1985	Urla - İzmir	20.00	Pergent and Pergent 1985
2	2003	İzmir Gulf	3 900.00	Dural *et al.* 2013
3	2004	Datça -Bozburun SEPA	4 120.00	Okuş *et al.* 2007
4	2004-2006	Paşalimanı, Narlı, Çanakkale Strait, Sea of Marmara	1 339.10	Cirik *et al.* 2007; Cirik and Akçalı 2013
5	2005	Foça SEPA	670.00	Akçalı *et al.* 2019
6	2006	Gökova SEPA	690.00	Okuş *et al.* 2006
7	2007-2009	Fethiye-Göcek SEPA	2 840.00	Ünlüoğlu *et al.* 2009; Derinsu 2009
8	2008	Gökçeada-Çanakkale	NA	Pergent *et al.* 2013
9	2008	Turgutlar - Mersin	NA	Pergent *et al.* 2013
10	2010	Karaburun -İzmir	4.40	Akçalı *et al.* 2010
11	2010	Ölüdeniz in Kaş-Kekova SEPA	104.70	Akçalı *et al.* 2019
12	2011	Ayvalık Adaları NAP	1,080.00	Bann and Başak 2013***
13	2011-2012	Antalya Bay	NA	Mutlu *et al.* 2014
14	2015	Marmaris - Muğla	156.00	Yüksek *et al.* 2015; Yılmaz *et al.* 2017
15	2015	Antalya (Ufakdere-Kaş) in Kaş-Kekova SEPA	2.10	Demir *et al.* 2016
16	2015	Güllük-Muğla	251.63	Bakırman *et al.* 2016
17	2016	Gülbahçe -İzmir	1 393.00	Gier-Yücel *et al.* 2019
18	2017	Bodrum- Tilkicik Bay, Muğla	2.15	Güçlüsoy *et al.* 2017
19	2017	Edremit, Çandarlı, Ildır, Gülbahçe, Gökova, Güllük,	NA	Duman *et al.* 2018
20	2018	Kaleköy, Gökçeada-Çanakkale	0.52	Aslan *et al.* 2018
Total			**14 486.20 ha**	

*Date refers to the mapping date given at the methodology of each study.
**SEPA: Special Environmental Protection Area, NAP: Nature Park, NA: Distribution mapped but no coverage information given, Gray shaded areas were not considered for the total coverage calculations.
***The study results were held by ODTÜ-SAT (Sualtı Topluluğu Ekoloji Grubu) as an unpublished data in 2011.

Figure 1. The locations of *Posidonia oceanica* mapping studies from 1985 to 2019 (Basemap layers from Natural Earth database, http://www.naturalearthdata.com)

The calculated total coverage of the *P. oceanica* meadows along the Turkish coasts is still an underestimated figure and could not be perceived and/or used as a representative parameter for the distribution of the species in spatial planning efforts mainly due to two main reasons. Firstly, some of the calculated coverages referred in this study focused on local distributions and could not be extrapolated to overall region (e.g. studies # 4, 15, 16, 18 and 20 in Table 1). Secondly, there are some other confirmed *P. oceanica* meadows along Turkish coasts which were not included to this study since they do not provide any coverage information (e.g. Aysel *et al.* (2005) at Bozcaada, Aysel *et al.* (2006a) at Hatay coasts, Aysel *et al.* (2006b) at Adana coasts, Aysel *et al.* (2006c) at Mersin coasts, Dural *et al.* (2012) at Aliağa, Çeşme, Sığacık, Gümüldür, Kuşadası and Bodrum coasts). Considering the *P. oceanica* meadows are the key and unique habitats for the Mediterranean coastal ecosystem (Ferrat *et al*. 2003; Boudouresque *et al*. 2006), it is evident that the mapping efforts on the *P.oceanica* meadows along Turkish coasts still remains as an urgent task if a spatial planning is to be implemented for conservation and monitoring purposes.

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2019 yılına kadar Türkiye kıyılarında *Posidonia oceanica* (Linnaeus) Delile dağılımı üzerine bir derleme

Öz

Bentik habitatların haritalanması denizel mekansal planlama ve yönetimi için gerekli ve aslında olmazsa olmaz bir araçtır. *Posidonia oceanica* (Linnaeus) Delile Akdeniz'e endemik önemli bir deniz çayırı türüdür. Bu çalışma, yayınlanmış ve gri literatürdeki, kaplayıcılık yüzölçüm bilgisi veren tüm haritalama çabalarını özetlemektedir. Derlenen bilgilerin ışığında, 2019 yılına kadar yapılan 16 çalışmada, *P. oceanica* yüzölçümü toplam 14.486,20 ha olarak raporlanmıştır. Ancak bu tahmini değeri, gerçek dağılım alanına ait yüzölçümünün çok altında kalan bir değer olduğu açıktır. Bu nedenle, Türkiye'de *P. oceanica* çayırlarının haritalanması çabaları denizel mekansal planlamasında kullanılabilir veri ve bilgiler sağlayamamaktadır ve halen acil bir araştırma konusu olarak gündemdedir.

Anahtar kelimeler: Habitat haritalama, *P.oceanica* dağılımı, Akdeniz, Marmara Denizi

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