



Disconnects in EU and Greek fishery policies and practices in the eastern Aegean Sea and impacts on *Posidonia oceanica* meadows

Eirini Ioanna Vlachopoulou^{a,b,*,1,2}, A. Meriwether Wilson^a, Anastasia Miliou^b

^a University of Edinburgh, School of GeoSciences, West Mains Road, EH9 3JW Edinburgh, Scotland, UK¹

^b Archipelagos, Institute of Marine Conservation, Marine Research Base: P.O. Box 152, Ormos, Marathokampos 83102, Samos, Greece²

ARTICLE INFO

Article history:

Available online 26 February 2013

ABSTRACT

Seagrasses provide essential ecosystem services to coastal communities, as they support key commercial marine species, biodiversity, tourism and coastal protection. Destructive fishing practices are having significant impacts on the seagrass meadows throughout the eastern Aegean Sea, in particular *Posidonia oceanica*. The majority of the local population in Greece are artisanal fishermen who rely on seagrass beds for their fisheries' catches. The European Union supports the protection of *Posidonia oceanica* meadows through marine protected areas under the *Habitats Directive* and through the *Common Fisheries Policy* (CFP). The CFP defines destructive fishing practices (e.g. trawling within 1.5 nautical miles of member state shorelines) formally as *Illegal, Unreported and Unregulated* (IUU) fishing practices. While destructive impacts of trawling on seagrass habitats are well documented, this fishing method poses a problem throughout the Mediterranean and elsewhere. Based on a case study of artisanal fishing communities in the Aegean Sea, this research examines the problem of destructive and illegal fishing in seagrass beds from both ecological and policy management perspectives, including: analyses of EU and Greek national fisheries legislation and a case study of two fishing communities in Greece, involving stakeholder interviews and habitat maps of fishery practices. Findings highlight disconnects in the application of fishing legislation between EU and Greek laws, socio-economic and institutional barriers to fisheries enforcement, and a lack of habitat baseline information. Recommendations focus on seagrass conservation through direct engagement of artisanal fishing communities in the management of local fisheries protection areas (FPAs) to support long-term survival of seagrasses ecosystems which sustain local fishing livelihoods today and for the future.

© 2013 Elsevier Ltd. All rights reserved.

1. Introduction

Marine seagrasses world-wide provide critical ecological functions and fundamental services to coastal societies. The intricate network of seagrass blades and root systems of create dense meadows that support hundreds of associated species, stabilise shorelines, improve water clarity (Borum et al., 2004; UNEP-WCMC, 2006) and play a role in carbon storage (Laffoley and Grimsditch, 2009). The rich biodiversity, extent and structure of the seagrass meadows also support numerous varieties of fish and other marine species seeking food and refuge around the seagrass beds (Mann,

2000; Waycott et al., 2009). *Posidonia oceanica* is endemic to the Mediterranean Sea and is one of the most productive species of seagrasses world-wide in terms of primary productivity (Borum et al., 2004; UNEP-WCMC, 2006). The clear waters and islands of the Mediterranean Sea provide ideal conditions for *Posidonia*, where the plants can grow down to 50 m depth (Borum et al., 2004), and establish several kilometres out from the shore in some locations. Seagrass beds support commercially valuable fishes, e.g. *Serranus* spp., *Diplodus* spp. and *Spicara* spp. (Batjakas and Economakis, 1999). They provide critical livelihoods to local artisanal fishing communities (Greek Statistical Service, 2008; Tzanatos, 2006).

Seagrasses throughout the world are highly threatened by destructive fishing practices, coastal reclamation and pollution, resulting in irreversible loss of their ecosystem services across many scales and sectors. *P. oceanica* is considered an endangered species and a priority habitat, formally protected through the *EC Habitats Directive* (92/43/EEC, 1992), which encourages and legally

* Corresponding author. Permanent address: Agapis 50, Irakleio Attikis, 14121 Athens, Greece.

E-mail addresses: iriannavl@gmail.com (E.I. Vlachopoulou), meriwether.wilson@ed.ac.uk (A.M. Wilson), a.miliou@archipelago.gr (A. Miliou).

¹ Tel.: +44 131 650 863.

² Tel.: +30 22730 37533.

underpins the establishment of 'marine protected areas' (MPAs) for priority habitats. In most cases MPAs are spatially-defined areas where designated activities are prohibited at all times (e.g. not allowing destructive fishing in a designated coral reef or seagrass bed at any time), or not allowing fishing during certain times of a year. As seagrasses are a benthic marine habitat, they are usually established as 'no-go' MPA areas through navigational boundaries, e.g. no trawling with a certain distance of shore through compliance with local code and/or coastal zone management measures (Dudley, 2008). Yet, in Greece and elsewhere, many seagrass beds exist outside of formal MPAs, so protection is through incorporating no-go areas into local zoning code with regard to fisheries and other coastal-marine habitat destroying development practices (Greek Republic, 2007; Panagiotidis, 2011).

The EU *Common Fisheries Policy* (CFP), includes definitions and mechanisms for *Illegal, Unregulated and Unreported* (IUU) fisheries practices in member states (Barcelona Convention, 1995; EC 2371/2002, 2002; European Commission, 2009; European Commission, 2010; 92/43/EEC, 1992). The CFP legislation regulating fisheries management are binding for the Member States, which are obliged to implement EU policies through national laws (EC 1447/1999; EU, 2006; Pliakos, 2006). Trawling is considered to be a fishery practice that is highly destructive to seagrass beds and other marine habitats, e.g. reefs, and therefore was banned in national territorial waters of EU member states, through the IUU facility of the CFP (EC 1626/94, 1994). However, it was not until 2011 that Greek fisheries legislation banned trawling in waters within 1.5 nautical miles (nm) of the coast.

The eastern Aegean Sea is an area of high marine biodiversity and rich in *P. oceanica* meadows and commercial fish stocks (HCMR, 2007; Stergiou et al., 1997), yet, little is known about the full extent and condition of the seagrass beds in this region. Research about the fauna of the wider Mediterranean Sea indicates healthy population of seagrasses still exist, but there is minimal documentation of location, extent and habitat condition (Salman et al., 2001). An important dimension regarding the condition of seagrass habitats and fisheries practices is the status of fish stocks in Greek seas, which have been declining for more than 15 years (FAO, 2009). After Greece entered the European Union in 1981 the Greek fishing sector expanded significantly, largely due to European fishery subsidies. In 1981 Greek landings were 101,460 tonnes, reaching a peak of 181,125 tonnes in 1994 (FAO, 2009). Since this time the annual quantity of Greek fisheries landings has been steadily dropping in spite of better fisheries capture technologies, suggesting the fish stocks are depleted (Greek Republic, 2007; Waycott et al., 2009). In 2009, fisheries capture production for Greece had fallen at 83334 tonnes, less than half its 1994 level (FAO, 2009). Presently, most local, small-scale artisanal Greek fishermen use nets that float above the seagrass beds and do not destroy the habitat (HCMR, 2007; Stewart, 2001). However, the combination of more advanced fishing equipment and the increasing use of large-scale fishing ships in Greek waters are displacing artisanal fishers and is resulting in competition amongst local and commercial fishing groups (Anagnopoulos et al., 2000; Greek Republic, 2007; Stergiou et al., 1997; Tzanatos, 2006).

In order to understand the dynamics between the fisheries and marine conservation policies and practices that dictate the ecological fate of seagrass beds and livelihoods of artisanal fishing communities, a case study was conducted on the islands of Samos and Fourni in Greece. This research was conducted for a Master of Science thesis (Vlachopoulou, 2011) over a 4 month period, with following goals:

- a. to examine to how EU and national legislation, in particular *Illegal, Unreported and Unregulated* (IUU) fishing practices as

defined by the EU legislation, was interpreted and enforced at different levels, if this had an impact on seagrass habitats in Greek coastal waters;

- b. to ascertain the different roles, perceptions and fishing practices of local community members whose fishing livelihoods are dependent on seagrasses, including: resident artisanal fisherman, fisheries authorities, non-governmental groups and other stakeholders;
- c. to expand the knowledge base on the location and condition of seagrass beds in the study area;

Given that destructive fishing practices often results in coastal-marine habitat loss and compromises the longevity and quality of livelihoods of local fisherman world-wide, it was hoped that insights gained from this case study research would provide insights on local fishing policies and practices that would help reduce the degree to which seagrass habitats are being destroyed through trawling throughout Greece and elsewhere.

2. Methods

2.1. Study area

This study focused on the coastal marine areas and fishing communities of Samos and Fourni islands as illustrated in Fig. 1. These islands have abundant seagrasses and local communities, and have a long tradition of artisanal fishing as their primary livelihoods. The first site, Ormos Marathokampou is a bay in southwest Samos with 221 inhabitants³ (Greek Statistical Service, 2008). The second site is the nearby Fourni Island Complex, an area with 1450 inhabitants (Greek Statistical Service, 2008). In both sites, approximately 20% of the population is employed in artisanal fisheries (Greek Republic, 2007; Tzanatos, 2006), and both have extensive seagrass beds which are impacted by a range of large and small-scale of fishing practices.

The *P. oceanica* meadows of these islands were subject to overfishing and destructive fishing methods, such as bottom trawling and dynamite fishing (Archipelagos, 2012; Greenpeace, 2006; Greenpeace Greece, 2008). Enforcement of local directives intending to ban trawling in Samos and Fourni were hampered by a lack of baseline mapping and monitoring of the *P. oceanica* meadows for these areas. In the late 2000s, a non-governmental organisation "Archipelagos Institute of Marine Conservation" (AIMC) had been mapping and monitoring seagrasses for a *Natura 2000* marine protected area in the southern part of Samos island. Since 2010 the AIMC had also been working to also prepare detailed marine maps and monitoring of seagrass beds outside of protected areas were the beds were vulnerable to destructive fishing practices (Archipelagos, 2010).

The seagrass meadows in the study sites were located in the shallow coastal zones extending down to the 50 m water depth, often within 1.5 nautical miles from shore. In both Samos and Fourni, the local fishermen used traditional, low-impact fishing methods such as trammel nets, gillnets, trolls, traps and long lines; while non-local Greek, offshore fishermen used purse seines and bottom trawlers (FAO, 2006). In 2010, the Greek government banned fishing with the use of boat seines within a 1.5 nm buffer zone to protect the nearshore marine habitats and to be compliant with EU regulations 1967/2006. However based on information from

³ All the demographic information is based on the Greek census of 2001 as the results of the Greek census of 2011 had not been released during the preparation of this paper.

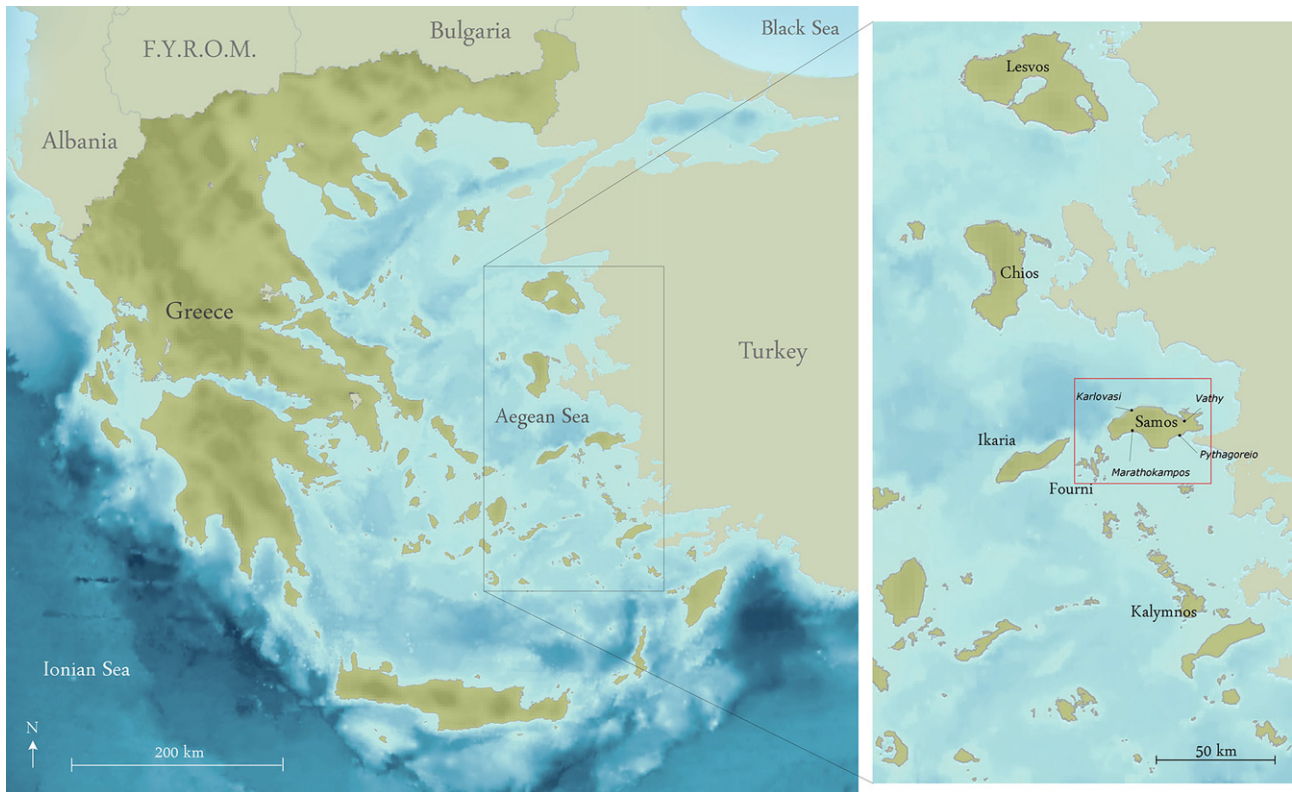


Fig. 1. Aegean Sea and study sites of Samos Island and Fourni Island. Source: Tammi, 2011.

AIMC, there was still substantial illegal trawling in the seagrass beds (Vlachopoulou, 2011).

2.2. Methods

To examine the inter-related ecology, policy and socio-economic dynamics of destructive and illegal fishing in seagrass habitats, the researcher was based in Samos and Fourni between May–July 2011, working with the AIMC and local communities. Several types of research methods were utilised including: i) semi-structured interviews with fishing and government stakeholder groups; ii) direct observation of ecological condition of seagrass beds, including observation of trawling tracks with snorkel and video; iii) preparation of GIS-based maps of the seagrass areas in the sites; iv) stakeholder mapping workshops with the GIS maps to gain local knowledge of fishing and seagrass conflicts; v) examination of AIMC archives of daily fisheries surveys and records of illegal fisheries complaints since 2009; and vi) policy analysis comparing EU and Greek legislation on fishing and conservation practices relevant to maintaining favourable condition of seagrass habitats.

The semi-structured, open-ended interviews (Corbetta, 2003; Yin, 1994) relating to issues of fisheries and seagrasses were conducted with 24 stakeholder informants, in groups up to 4 persons. A list of questions was used as a guide to the different roles of stakeholders, with time available for interviewees to add information they also considered important. There were 4 categories of stakeholders with different roles with the fishing community. The first category included fishermen from each of the two study areas, as the areas had different levels of fisheries depletion, potentially resulting in different perceptions about fishing practices and habitat conditions. The second category included various local authorities responsible for: habitat protection, combating destructive and illegal fishing, and the provision of assistance and support for

the fishing communities. The third category included members of the families of the fishermen and elderly fishermen who used to be professional fishermen. The fourth category consisted of fisheries experts which were not directly affected by the fishing industry but had an interest in conserving the marine habitats, e.g. members of the AIMC and divers. The personal details of the interviewees remain confidential by request.

In collaboration with the members of the AIMC Geographical Information System (GIS) team, 4 public participation GIS-based workshops were organized with fishermen from the two island study sites. During the workshops, the attendees were asked to add information to GIS maps regarding: the locations of *P. oceanica* meadows, trawler routes, current and depleted fish stocks and other information about local fishing activities and marine habitats. Additional information supporting the maps included videos of destructive and illegal trawling on the seagrass beds made previously by the AIMC. With regard to understanding the fishery and habitat policies, extensive documents on EU and Greek policies were acquired through libraries and local sources, including fisheries data and logs specific to the two study sites. It was hoped that a combination of place-based research methods (interviews, mapping workshops, and policy document analysis) would collectively provided a deeper understanding of the complexities that exist between stakeholder groups, laws, fishing methods, ecological impacts for this case study, and others.

3. Results and discussion

3.1. Differences between the two levels of legislation

Until recently, Greek fishing legislation was not formally amended to be in compliance with European Union legislation, making enforcement of destructive fishing more difficult. Two

examples relevant to seagrasses include: differences in minimum landing size of some high commercial value fish species and differences in exclusion zones for the use of towed (trawling) gear until new Greek legislation was passed in 2011. With the introduction of the Council Regulation (EC) No 1967/2006 of 21 December 2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea, fishing trawlers were banned from fishing within a buffer zone of 1.5 nm from the coast for all EU member states, allowing only for some limited exemptions to be made by the member states. However, the Greek legislation did not conform to European legislation until 2011, so until that time, trawlers according to national law could operate up to 1 nm to the shore. In April 2011, the Greek Ministry for Maritime Affairs, Islands and Fisheries introduced (MMAIF) Decree 9131.4/1/2011/11 stating that operation of trawlers within 1.5 nm from the coast was not allowed. However, this decree included an exemption allowing trawlers to still fish at 1 nm from the shoreline for approximately 45% of the Greek coastline (Vlachopoulou, 2011). According to the EC 1967/2006 (article 13 paragraph 5), exemptions may only be introduced if they are “justified by particular geographical constraints, such as the limited size of coastal platforms along the entire coastline of a Member State or the limited extent of trawlable fishing grounds, where the fisheries have no significant impact on the marine environment and affect a limited number of vessels, and provided that those fisheries cannot be undertaken with another gear and are subject to a management plan”. Apart from the fact that the decree did not include any justifications for excluding such a large proportion of the coastline, the MMAIF did not follow the procedural steps to have the trawling exemptions evaluated by the Commission before introducing the decree, rendering thus the decree non legalised (Damanaki, 2011). After intervention from the European Commissioner for Maritime Affairs and Fisheries, the Greek Ministry withdrew the exemption in August 2011, so technically, no trawling was allowed anywhere in Greek waters up to 1.5 nm (Damanaki, 2011).

The landing of many undersized, according to the EU legislation, commercial species in Greek ports is still considered legal according to the Greek legislation (HCMR, 2007). Detailed examples of discrepancies between the European and Greek minimum landing sizes are included in Table 1.

3.2. Current condition of the fish stocks in the study area

Seventy-eight percent of the interviewed fishermen stated that the fish stock levels have declined significantly in the past 10 years. These impressions are consistent with results of AIMC surveys conducted in Ormos Marathokampou between 2009 and 2011. Their surveys showed that total catches of the artisanal fishermen

for the months January–May 2011 reduced by 51% compared to levels in 2010 (Archipelagos, 2011). The catches of some species of high commercial value, such as the Common Dentex (*Dentex dentex*) and the White Seabream (*Diplodus sargus*), have decreased by up to 88% between 2010 and 2011 (Archipelagos, 2011). The interviews with the fisherman indicated that the main impact factor for the decline in fishing stock was trawling fishing within 1.5 nm of the coast. As trawling is destructive to seagrasses and other marine benthic habitats, it was technically illegal as per the EC 1967/2006, applicable to EU member states, however, Greek laws were only changed to be compliant in 2011, leaving the legality with regard to allowed trawling locations trawling ambiguous to some fishermen.

3.3. Stakeholder mapping of trawling fisheries in the study areas

During the public participation GIS workshops in May–July 2011, stakeholders identified the destructive trawling fishing activity within 1–1.5 nm of the shoreline of Fourni and Samos study areas. Trawling within 1 nm from the coast is banned at all levels of legislation, both European and Greek. However, it was a common practice in the study area according to the interviews. The maps below were produced based on the results of the workshops (Figs. 2 and 3). In addition, as the seagrasses often extended beyond 1–1.5 nm from the coast so the trawlers operating within the 1.5 nm buffer zone were illegal from the perspective of the EC 1967/2006 fishing legislation, but also the EC Habitats Directive (92/43/EEC, 1992), EC 1626/94, which prohibits the use of towed gear in *P. oceanica* meadows.

As the maps indicate, trawling activity takes place illegally within 1 nm from the shoreline, and often in the seagrass beds. The green lines indicating the meadows of the study area, show where the beds start but not where they end. According to mapping and monitoring done to the beds, both at the area under examination and elsewhere, they usually extend as far as 1.5–2 nm from the coast (HCMR, 2005; Vlachopoulou, 2011). As a result, the trawling routes depicted on the maps (Figs. 2–3) concur within sites formally protected by the European legislation, *P. oceanica* meadows.

Additional potential evidence of destructive and illegal trawling activity the study area of Samos was provided by the AIMC, during a video recording on the condition of the seagrass beds. The video showed areas with wide lines of sand-only seabed with no seagrasses in the middle of otherwise dense meadows of seagrasses. In areas where seagrass bed establishment is patchy, there would not normally be straight lines of exposed sand through the meadows, so trawling activity is a possible explanation. The video was recorded at 27 m depth and at a distance of 0.31 nautical miles from the coast.

3.4. Enforcement of the EU legislation on fishing methods

According to the interviews on fishing gear and methods, the use of trawlers is the least well enforced of all the EU fishing practices that are defined as “Illegal, Unreported and Unregulated” (IUU). Interviewees said that trawlers were often seen operating at a distance less than 1 nautical mile from the coast and in the seagrass bed areas, in breach of both the European and the Greek laws as discussed earlier and illustrated in Figs. 2–3. Interviewees also noted the incidents of trawling operations were more frequent in areas less monitored by the authorities, due to the lack of staff and equipment. For example, the northern part of Samos was better protected than other areas for two reasons. Firstly, two of the largest coastguard departments were located in northern Samos, one of which had a speedboat. Secondly, the main touristic port is located in northern Samos and many touristic towns are located

Table 1
Comparison of minimum tradable sizes according to the EU and Greek legislation.

Scientific name	Minimum size in cm – Greek Legislation		Minimum size in cm – EU Legislation	
1. Fish				
<i>Dicentrarchus labrax</i>	23		25	
<i>Diplodus sargus</i>	15		23	
<i>Pagellus erythrinus</i>	12		15	
<i>Scomber japonicus</i>	12		18	
<i>Trachurus</i> spp.	12		15	
2. Crustaceans				
	Total length	Carapace length	Total length	Carapace length
<i>Hommarus gammarus</i>	24	8.5	30	10.5

Source: HCMR, 2007.

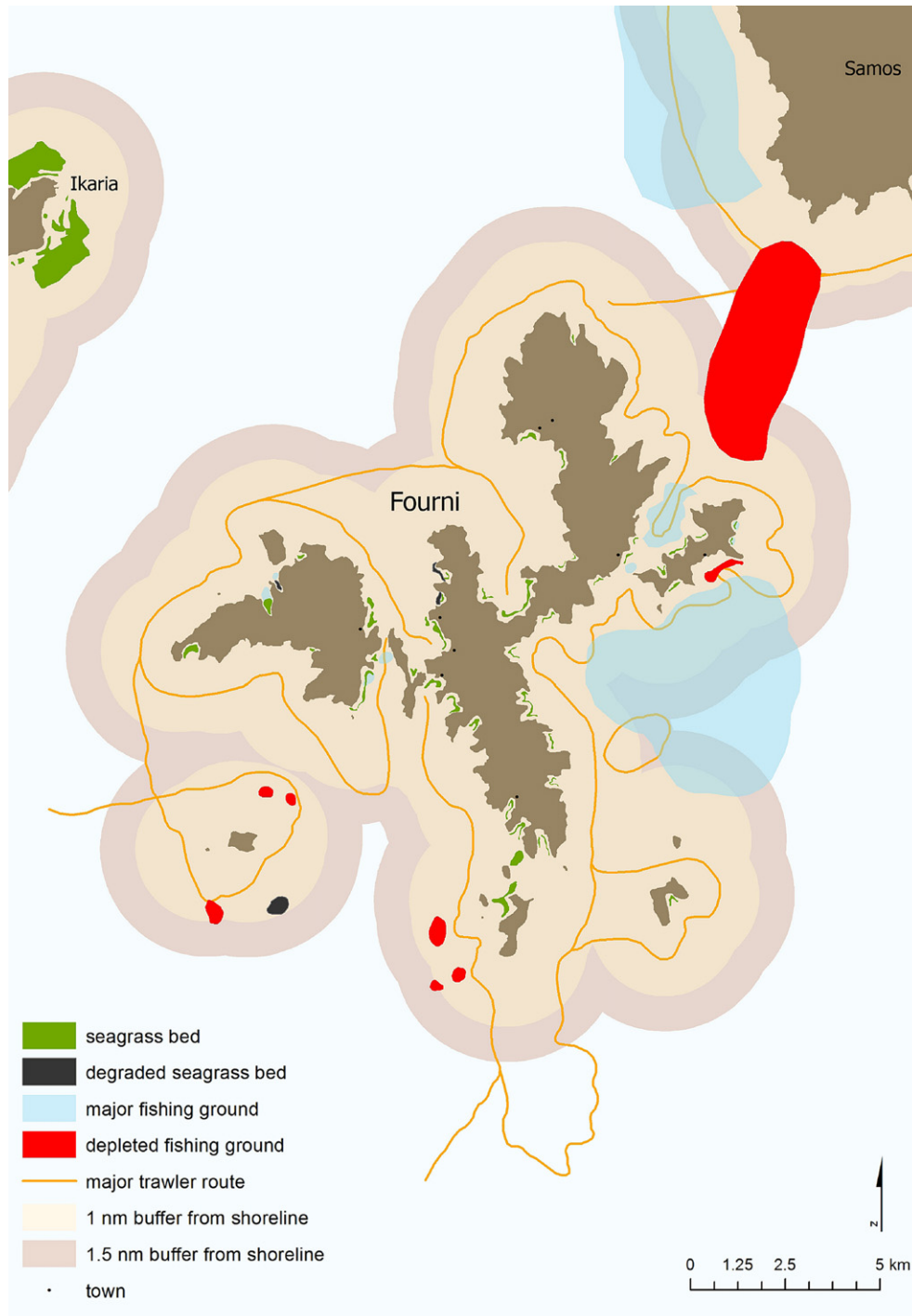


Fig. 2. Stakeholder participation GIS map of Fourni that shows the current and degraded seagrass beds, the current and depleted single species fish stocks and the trawling routes. Source: Tammi, 2011.

along the northern shore. In contrast, the interviewees noted difficulties for the coastguard to monitor and patrol more remote areas.

3.5. Enforcement of the laws on fishing vessel fleet capacity and quotas

As mandated by the EC Regulation 2371/2002 (2002), “a new fishing vessel cannot join the fleet unless another of the same

capacity and engine power has left it”. Official European data for 2010 indicates that 17,258 fishing vessels were registered in Greece (European Commission, 2010). In addition to registrations, the use of Vessel Monitoring System (VMS) devices to monitor boat locations was introduced by the EU in 2003. By January 2004 vessels exceeding 18 m length were required to have a VMS. By 2005 this included vessels exceeding 15 m in length (EC 2244/2003 2003) as well as a requirement for boats to have on-board Global Positioning Systems (GPS) to provide vessel locations every 2 h. In May 2011, a

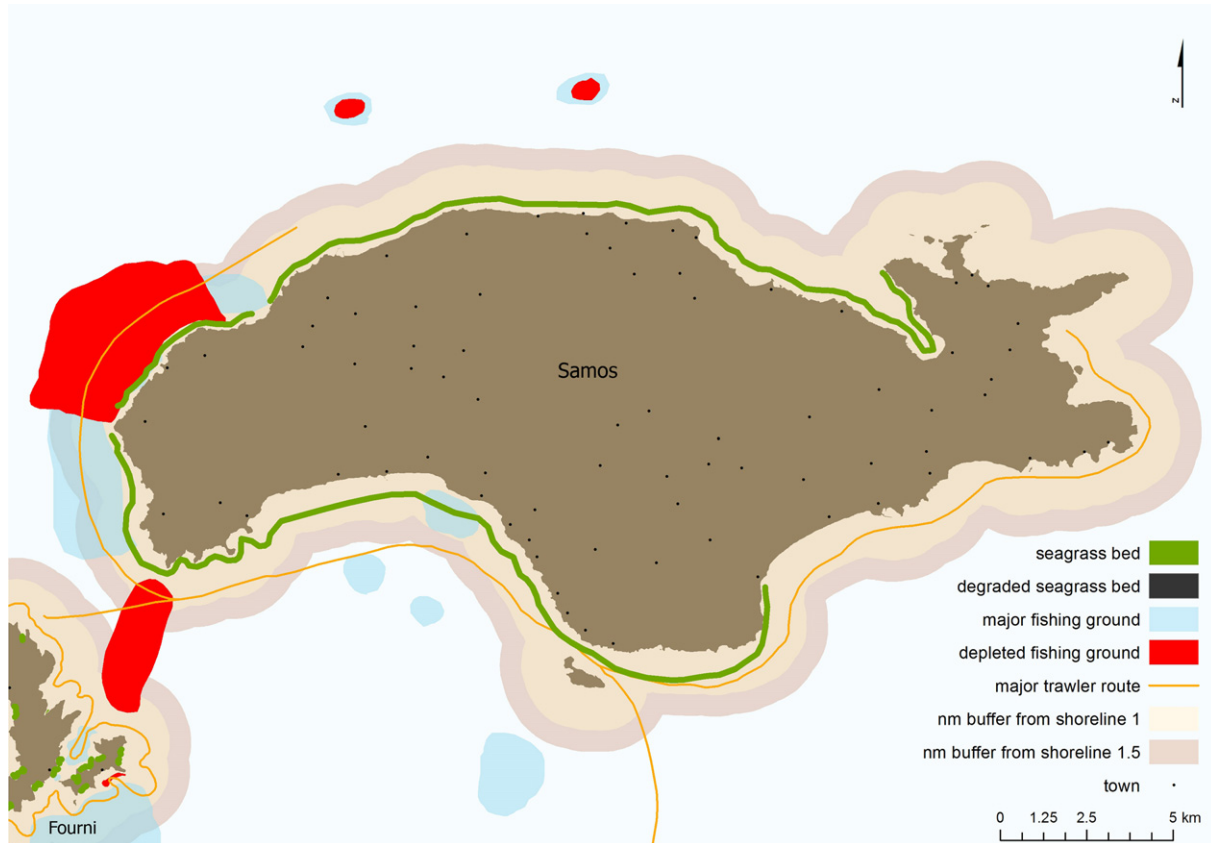


Fig. 3. Stakeholder participation GIS map of Samos that shows the current and degraded seagrass beds, the current and depleted single species fish stocks and the trawling routes. Source: Tammi, 2011.

business owner in Patiniotis Gulf, Samos, witnessed a trawler named 'Pigasos' fishing approximately 200 m from the coast. The observer reported the boat to the AIMC, who informed the Greek Ministry of Maritime Affairs, Islands and Fisheries⁴ to locate the trawler with through the VMS and/or GPS registry systems. The Ministry reported no transmission of a VMS signal in the area and that there was no trawler registered under the name 'Pigasos' (AIMC, 2011, personal communication, 19 May 2011). While this was just one occurrence during the May–June 2011 research study period, it illustrates that unregistered illegal fishing vessels were in the study site vicinity.

3.6. The roles of local fisheries authorities

There are two regional authorities responsible for the control of illegal fisheries, i.e. the Coastguard and the Fisheries Management Regional Offices (FMROs). According to interviews with representatives from these authorities, both their mandate and their ability to manage illegal fishing practices were unclear. For example, in comparing responses of two officers from two different FMROs, one in Vathy, Samos (Fig. 1) and the other in Eastern Macedonia and Thrace⁵ they had contradictory perspectives on their roles. The respondent from the Samos FMRO insisted the only responsibility

of the FMRO was to inform stakeholders about updates in the fisheries legislation. While the official of the Eastern Macedonia and Thrace FMRO claimed that they could not provide law information to the public and fisheries communities as such actions were not included in their responsibilities (personal communication, 24 June 2011). Similarly, an official of the Karlovasi Coastguard, who oversaw the north-western part of Samos area, claimed that the Karlovasi branch was not entitled to take any action against illegal fisheries, and only obliged to forward any complaints to the central Coastguard branch in Piraeus.

Officers of the Coastguard were also lacking adequate equipment and training needed to combat destructive and illegal fisheries, such as trawling. The officer in charge of the Vathy Coastguard speedboat, the only marine vessel available to the Coastguard of the entire study area, emphasised that the Coastguard staff has limited training and often did not have vital resources such as fuel for the speedboat. The officer also noted that the speedboat crew had more duties and responsibilities than they could effectively enforce, e.g. from illegal fishing control, to illegal immigration patrolling and boat registries.

In comparing the interviews of the maritime officials with the other stakeholders, it was apparent that there were differences in awareness and perception regarding the degree to which destructive trawling fishing was occurring close to the shore. For example, officers from the Karlovasi and Vathy branches of the Coastguard said they either had never received official complaints regarding illegal fishing activity, or had received reports on only minor instances. In contrast, the president of a recreational fishermen's association in the study area claimed that they had witnessed illegal trawling activity in the study area several times and attempted, unsuccessfully to get the attention of the authorities.

⁴ During the Greek Government Reshuffle of 18/06/2011, the Ministry of Maritime Affairs, Islands and Fisheries was abolished and the sectors of Maritime Affairs and Fisheries were absorbed by the Ministry of Regional Development, Competitiveness and Shipping.

⁵ Even though Eastern Macedonia and Thrace are not in the areas under examination, their statements were used as comparison to the statements of the FMRO of Vathy.

3.7. Conflicts of interest and community pressure

The interviews across different stakeholders also revealed that an underestimation of the problem of destructive and illegal trawling is not only common amongst the maritime authorities, but also with local community members who were aware of incidents but were reticent to report them. According to the interviews of the local fishermen and residents of the study area, witnesses may have been discouraged to make official complaints for two main reasons. First, some were afraid that they might be accused for breaching the law themselves, and/or, second, they were personally acquainted with the illegal fishers and consider bringing charges against them as a breach of personal confidence. While this research focused on the destructive practices of trawling, EU laws also have restrictions on the size and species of fisheries. This is relevant, as interviews noted that sometimes artisanal fishermen justified carrying out minor infringements due to the decline of the local fish stocks, which in part was blamed on trawling and larger-scale fishers. For example, some artisanal fishers caught endangered species such as Slipper Lobsters (*Scyllarides latus*), which were prohibited to land and sell, in order to supplement their low income. If they contacted the authorities regarding the trawlers, they could have placed themselves in danger of revealing their own infringements.

Interviews with local artisanal fishermen and community members indicated another reason they did not report fisheries infringements was that some considered the fisheries authorities to be ineffective at their jobs. The majority of the artisanal fishermen interviewed believed that the Coastguard was cooperating with illegally operating trawlers resulting in limited documentation of major infringements. However, most common reason noted for under-reporting of infringements was personal acquaintance with the perpetrators. Members of local communities were concerned that they would betray relatives or colleagues by making official complaints to the authorities. Witnesses feared that they will be looked down upon by their peers, which limited information exchange with the authorities to combat illegal fishing practices. As a member of recreational diving team mentioned, even if the fisheries authorities were operating effectively, it would be difficult to safeguard the whole study area as the coastline is very long and the Coastguard needed assistance from the public.

4. Conclusion and recommendations

Overall, this research revealed that the EU legislation regarding destructive and illegal fisheries in near-shore marine waters was not enforced effectively in the study area, and may represent similar challenges elsewhere. While most the authorities responsible for the implementation of the law were willing to establish a control routine, it was difficult, due to limited time and resources to manage multiple responsibilities and duties. Key issues were inadequate training and a lack of centralised support, resulting in local fishermen having limited confidence in the Coastguard. Although the Greek government could have been taken to court by the EU level for non-compliance with the European Union legislation regarding illegal fishing practices, efforts were still needed on the ground, and many officials were unwilling to fight corruption and commit themselves to the combat against illegal fisheries.

Considering that effective implementation of destructive fishing practices and laws was challenging for both the national and local levels of Greek government departments, and the general difficulty in managing large marine areas, a change in approach to how the laws are viewed and enforced is needed. For example, if local authorities and the local fishing communities fully understood the multiple ecosystem services that seagrass habitats provide, and that destructive trawling fishing eliminated these services,

implementation of the fisheries legislation at both the national and the EU level could potentially be improved. A robust evaluation of the mandate and delivery of the fisheries enforcement and management work conducted by the fisheries authorities is needed to ensure more effective distribution of roles and responsibilities, for example, currently the Coastguard has more duties than can be achieved with limited staff, training and equipment. A partial solution is to more fully engage the artisanal fishing communities to be part of control mechanism of the areas they live and work, as their livelihoods are directly affected by destructive fishing and declines in seagrass habitat. For example, community rangers could assist the authorities to combat illegal and destructive fishing practices, in a way that encourages all fishers not to execute small scale infringements of their own. Additionally, control of such a large marine area and enforcement of complex EU and Greek fishery laws would be unachievable without the collaboration of the artisanal fishermen.

4.1. Mapping for science and community participation

Challenges inherent in protecting a habitat on which key fisheries depend, requires significant effort as many parameters have to be addressed. At the outset, raising awareness of the ecology of the *P. oceanica* meadows is fundamental. There is a need to understand the importance of the seagrasses for a healthy fishing industry and that the local fishermen rely on the seagrasses for their livelihoods. If the seagrass beds become further fragmented, the already low numbers of fish stocks are likely to disappear. In the case of the *P. oceanica* meadows, protection of the remaining seagrass beds is crucial (Waycott et al., 2009). Therefore, a key direction is to focus on better mapping and monitoring of the *P. oceanica* meadows to establish and maintain a viable sustainable management plan, based on knowledge of the location, extent and ongoing condition of the habitat. As evident through this research, the AIMC mapping project is one example of a mechanism that achieves both scientific goals and fosters local communication and engagement.

Ideally better mapping and the connection between habitat and sustainable fisheries practices could justify protection of known beds beyond 1.5 nm, as seagrass beds often grow beyond this jurisdictional boundary. Careful planning is needed so that the fishermen, both artisanal and large-scale, will not associate habitat conservation with income and livelihood losses. Additionally, as proven with various sustainable harvesting certification efforts, consumers have the power to influence the fishing industry, by being informed about catch sizes, life history aspects of fishes and other marine species. This could reduce the trade in undersized or illegally caught fisheries. If such practices were driven by community efforts, this would also contribute to minimizing destructive and illegal fishing practices by local fisherman and establish a social climate in which reporting illegal trawling was rewarded rather than discouraged.

4.2. Proposed Fisheries Protection Area

The Common Fisheries Policy of the European Union encourages local communities to establish Fisheries Protection Areas (FPAs) in order to assist with recovery of the local fish stocks and demonstration of sustainable fisheries. The population of Fourni is highly dependent on fisheries (Tzanatos, 2006). Due to the decline of fish stocks, their livelihoods were being eroded. Given the lack of enforcement of the law in the area, there was also local support for additional action towards a more sustainable fisheries management. This situation combined with increasing realization of the impacts of destructive trawling on the seagrass beds, the residents and professional fishermen of Fourni and the local authorities and AIMC, are now in the planning stages of establishing the first Fisheries Protection Area in the Greek national waters (Uffman-Kirsch, 2011).

Currently, the only formal way that fishermen can an area is for an FPA to be established according to the EU standards. The president of the fishermen's association of Fourni, stated their position: 'There is no capability for control and the illegal fishing practices have become uncontrollable. If there was an external authority, it would discourage illegal fishing practices. We want to control the area ourselves but the Greek legislation does not allow us to do so' (interview with author, 02–03 July 2011). The AIMC supports the initiative and will provide the participating parties with all the scientific knowledge, information and assistance necessary for the project to succeed. The Head Researcher of AIMC, commented on the FPA (interview with author, 08 July 2011): 'We are happy to see that many communities in the Aegean are taking initiatives in order to establish self-regulated fisheries protection areas. This is something we rely on and want to support scientifically with the collaboration of the European Commission which is very interested in this area. Our aim is to support initiatives of local fishermen's associations, communities and authorities in order to create self-regulated fisheries management areas.'

The introduction of a self regulated FPA in the region, in which stakeholders with knowledge of the local environment will participate, could provide a long-term means for protection of the *P. oceanica* meadows. The mapping and monitoring of the beds would be simplified, as AIMC as part of a team with fisherman and community members, would also have a presence in the area through monitoring. Additionally, by discouraging destructive fishing practices within the FPA, the fishermen could support the recovery of both the fish stocks and the damaged seagrass beds.

4.3. Opportunities for further research

This study examined only two of the different methods of destructive fisheries, illegal trawling and dynamite fishing in near-shore waters. Dealing with the wide range of illegal fisheries that are practiced in the area of the eastern Aegean Sea would require a more detailed analysis and examination of the parameters and interviews with many stakeholders. A wider analysis in the future would greatly contribute to the knowledge pool upon which the Fourni FPA and other similar community-lead marine conservation initiatives could be based. The establishment of the Fisheries Protection Area in Fourni would allow for further research on the impact of illegal fisheries on the *P. oceanica* meadows that has wider implications. Monitoring of the progress of initiative could provide researchers with information about stakeholder involvement in the regulation and control of important fishing grounds and whether such actions help discourage destructive and illegal fishing activities. Long term fisheries surveys will reveal whether a fisheries protection area could assist the fish stocks of the region and marine habitat observation will determine how the fisheries protection area may affect the *P. oceanica* meadows.

Furthermore, the research could be expanded to include other parts of the national waters of Greece or even of the Mediterranean. Detailed analyses of the current state of affairs on illegal fisheries are rare and the compilation of such reports will contribute greatly towards changing fishing practices away from actions which harm the ecosystems and livelihoods, to measures which ensure seagrass resources and associated services are sustained for current and future generations.

Acknowledgements

The authors would like to acknowledge the staff of the NGO Archipelagos Institute of Marine Conservation, for their logistical and information support, and Ilpo Tammi for assistance with the

GIS mapping, as well as other contributing researchers: N. Austin, S. Cheney, G. Reeve.

References

- Anagnopoulos, N., Papakonstantinou, K., Economou, A., Papacharisis, L., and Fragoudi, K., 2000. Recreational fishing in the Eastern Mediterranean (Greece–Italy): parameter estimation, relationships and conflict with commercial fishing. In: Proceedings of 9th National Conference of Ichthyologists, Mesolongi, pp. 295–297.
- Archipelagos, 2010. Coralligene Reefs and Posidonia Seagrass. <http://www.archipelago.gr/index.php?page=seagrass-coralligene> (accessed 02.04.12.).
- Archipelagos, 2011. Press Release: 'Without laws and rules become the fish of the Aegean Sea extinct'. *Agrotikos Synergatismos Monthly* 100, 40–42.
- Archipelagos, 2012. The Allegations Made by Archipelagos Cause Two Parliamentary Interventions in Relation to Dynamite Fishing. <<http://www.archipelago.gr/index.php?mact=News, cntnt01, detail,0&cntnt01articleid=39&cntnt01origid=66&cntnt01detailtemplate=details&cntnt01returnid=66>> (accessed 02.04.12.).
- Barcelona Convention: Convention for the Protection Of The Mediterranean Sea Against Pollution, signed 16 February 1976, in force 12 February 1978 (revised in Barcelona, Spain, on 10 June 1995 as the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean).
- Batjakas, I.E., Economakis, A.E., 1999. Coastal Fishes of Greece. Efstathiadis Group A.E, Athens.
- Borum, J. (Ed.), 2004. European Seagrasses: An Introduction to Monitoring and Management. A publication by the EU project Monitoring and Managing of European Seagrasses (M&MS).
- Commission Regulation (EC) No 2244/2003 of 18 December 2003 laying down detailed provisions regarding satellite-based Vessel Monitoring Systems. *Official Journal L*, 333, 20.12.2003, pp. 17–27.
- Corbetta, P., 2003. Social Research: Theory, Methods and Techniques. Translated from Italian by B. Patrick. SAGE Publications Ltd, London.
- Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (EC Habitats Directive). *Official Journal L*, 206, 22.07.1992, pp. 7–50.
- Council Regulation (EC) No 1626/94 of 27 June 1994 laying down certain technical measures for the conservation of fishery resources in the Mediterranean. *Official Journal L*, 171, 6.7.1994, pp. 1–6.
- Council Regulation EC 1447/1999 of 24 June 1999 establishing a list of types of behaviour which seriously infringe the rules of the Common Fisheries Policy. *Official Journal L*, 167, 2.7.1999, pp. 5–6.
- Council Regulation EC No 2371/2002 of 20 December 2002 on the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy. *Official Journal L*, 358, 31.12.2002, pp. 59–80.
- Council Regulation (EC) No 1967/2006 of 21 December 2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea, amending Regulation (EEC) No 2847/93 and repealing Regulation (EC) No 1626/94. *Official Journal L* 409, 30.12.2006, pp. 11–85.
- Damanaki, M., 2011. Answer E-007368/2011 (15 September 2011) to Parliamentary Question E-006063/2011. *Official Journal C* 146 E, 24.05.2012.
- Decree 9131.4/1/2011/11, Minimum distance from the coast during fishing with the fishing tool "towed nets" (trawler according to the Royal Decree 917/1966). FEK 776 B/6-5-2011.
- Dudley, N. (Ed.), 2008. Guidelines for Applying Protected Area Management Categories. IUCN, Gland, Switzerland. accessed via: <http://data.iucn.org/dbtw-wpd/edocs/paps-016.pdf> (22 October 2012).
- European Commission, 2009. The Common Fisheries Policy – A User's Guide. Office for Official Publications of the European Communities, Luxembourg.
- European Commission, 2010. Facts and Figures on the Common Fisheries Policy – Basic Statistical Data, 2010 ed. Office for the Official Publications of the European Communities, Luxembourg.
- European Union, 2006. Consolidated versions of the Treaty on European Union and of the Treaty Establishing the European Community. *Official Journal C* 321, E1.
- Food and Agriculture Organization of the United Nations (FAO), 2006. Fishery Country Profile: Greece. ftp://ftp.fao.org/FI/DOCUMENT/fcp/en/FL_CP_GR.pdf (accessed 02.04.12.).
- Food and Agriculture Organization of the United Nations (FAO), 2009. Fishery Production Statistics: Greece Capture Production. <http://www.fao.org/figis/servlet/SQServlet?file=/usr/local/tomcat/FI/5.5.23/figis/webapps/figis/temp/hqp_27298.xml&outtype=html> (accessed 02.04.12.).
- Greek Republic, Ministry of Rural Development and Food, Special Secretariat for Planning Applications and 3rd Community Support Framework, 2007. National Strategic Development Plan for Fisheries 2007–2013. http://ec.europa.eu/fisheries/cfp/eff/national_plans/list_of_national_strategic_plans/greece_el.pdf (accessed 02.04.12.).
- Greek Statistical Service, 2008. 2001 Census of Population: Actual Population, Population Division. http://www.statistics.gr/portal/page/portal/ESYE/BUCKET/A1604/Other/A1604_SAP01_TB_DC_00_2001_01_F_GR.pdf (accessed 02.04.12.).
- Greenpeace, 2006. Marine Reserves for the Mediterranean Sea. <http://www.greenpeace.org/raw/content/international/press/reports/marine-reserves-med.pdf> (accessed 02.04.12.).
- Greenpeace Greece, 2008. Posidonia Oceanica Meadows: The Forests of the Sea. <http://www.greenpeace.org/greece/campaigns/oceans/marine-reserves/poseidonia> (accessed 02.04.12.).

- Hellenic Center for Marine Research (HCMR), 2005. State of the Hellenic Marine Environment. HCMR publications, Athens.
- Hellenic Center for Marine Research (HCMR), 2007. State of Hellenic Fisheries. HCMR publications, Athens.
- Laffoley, D., Grimsditch, G. (Eds.), 2009. The Management of Natural Coastal Carbon Sinks. IUCN, Gland, Switzerland.
- Mann, K.H., 2000. Ecology of Coastal Waters with Implications for Management, second ed. Blackwell Science Inc, Massachusetts.
- Panagiotidis, P., 2011. Management of Aquatic Ecosystems – Coastal and Transitional Waters, Part C: The Coast. In: Management of Aquatic Ecosystems. National Technical University of Athens. http://postgrasrv.hydro.ntua.gr/gr/edmaterial/education/panajiotidis/coastline_2007.pdf (accessed 02.04.12.).
- Pliakos, A., 2006. Institutions (in Greek). The Law of the European Union, vol. I. Athens University of Economics and Business and A. D. Pliakos publications, Athens.
- Salman, A., Bilecenoglu, M., Güçlüsoy, H., 2001. Stomach contents of two Mediterranean monk seals (*Monachus monachus*) from the Aegean Sea, Turkey. *Journal of the Marine Biological Association of the UK* 81, 719–720.
- Stergiou, K.I., Christou, E.D., Georgopoulos, D., Zenetos, A., Souvermezoglou, C., 1997. The Hellenic Seas: physics, chemistry, biology and fisheries. *Oceanography and Marine Biology* 35, 415–538.
- Stewart, P.A.M., 2001. A Review of Studies of Fishing Gear Selectivity in the Mediterranean. Copemed. http://www.faocopemed.org/old_copemed/vldocs/0000317/rev_sel.pdf (accessed 12.03.12.).
- Tammi, I., 2011. GIS Maps Prepared for Archipelagos. Institute of Marine Conservation, Samos, Greece.
- Tzanatos, E., 2006. Structure, Characteristics and Management of Small-scale Fisheries in Greece. Ph. D University of Patra, Department of Biology.
- Uffman-Kirsch, L., 2011. Local, Co-managed Fisheries: A Path to Sustainable Fishing in the Coastal and Island Communities of the Greek Seas? (unpublished directed research paper) New Orleans: Tulane University School of Law and Cleveland: Case Western Reserve University School of Law.
- United Nations Environment Programme – World Conservation Monitoring Centre (UNEP-WCMC), 2006. Marine and Coastal Ecosystems and Human Well-being; A Synthesis Report Based on the Findings of the Millennium Ecosystem Assessment. UNEP.
- Vlachopoulou, E.I., 2011. Enforcement of the European Union Legislation about Illegal Fishing Practices in the Eastern Aegean Sea and Its Impact on the Posidonia Oceanica Meadows. MSc. The University of Edinburgh, Department of Science and Engineering, School of GeoSciences.
- Waycott, M., Duarte, C.M., Carruthers, T.J.B., Orth, R.J., Dennison, W.C., Olyarnik, S., Calladine, A., Fourqurean, J.W., Heck Jr., K.L., Hughes, A.R., Kendrick, G.A., Kenworthy, W.J., Short, F.T., Williams, S.L., 2009. Accelerating loss of seagrasses across the globe threatens coastal ecosystems. *Proceedings of the National Academy of Sciences of the United States of America* 106 (30), 12377–12381.
- Yin, R.K., 1994. Case Study Research: Design and Methods, second ed. SAGE Publications, Inc, Thousand Oaks.