8.4 Eastern Mediterranean case (Thermaikos Gulf Case Study)

8.4.1 1. Brief presentation of the case study and fisheries concerned

Northwestern (NW) Aegean includes the Gulfs of Thessaloniki (also known as inner Thermaikos) and Thermaikos as well as the gulfs of Chalkidiki Peninsula. Thermaikos Gulf is the main fishing ground, which is considered one of the most productive in the Greek Seas. Thermaikos Gulf is a shallow water area having a maximum depth of 50 m (Figure 27). Large river systems (Gallicos, Axios, Loudias and Aliakmon) discharge into Thermaikos Gulf about 207m3/s, with significant temporal variability (Kallianiotis et al. 2004).

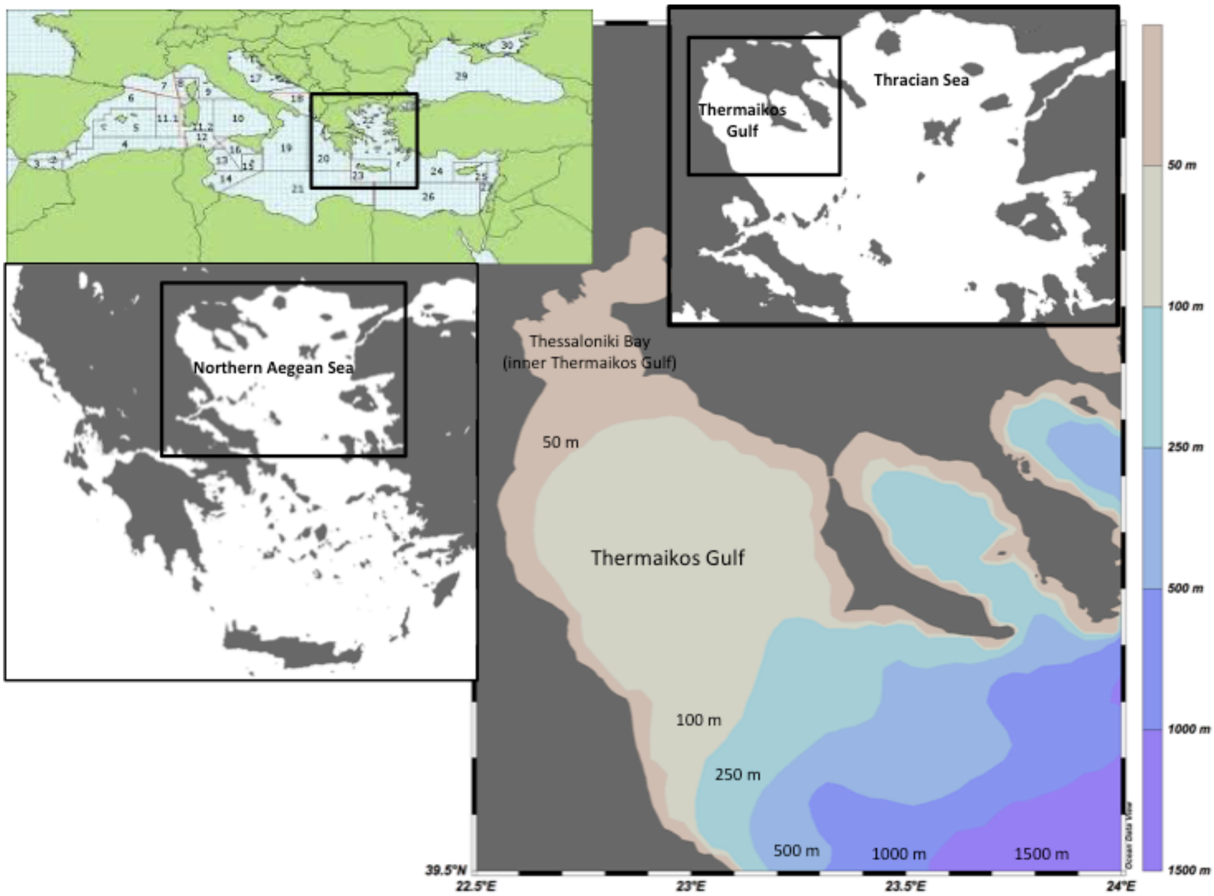

Figure 27: Map of the Mediterranean Sea showing the GSAs (GSA 22: Aegean Sea), northern Aegean Sea and Thermaikos Gulf (case study area) with seabed bathymetry.

According to the Fleet Register (KAM 2014), in 2014, 1460 vessels were registered in 7 ports of Thermaikos Gulf (Thessaloniki: 739 vessels; Skala Katerinis: 251 vessels; Nea Moudania: 232 vessels; Nea Michaniona: 82 vessels; Platamonas: 71 vessels; Agiokampos: 66 vessels; Stomio: 19 vessels). Based on the main gear used, 58 of these vessels are trawlers (using bottom trawls, OTB), 29 are purse seiners (using purse-seines, PS) and 1373 are small-scale coastal vessels using a variety of fishing gears. The percentage of active vessels to the total will be determined within the framework of this project.

Following Thracian Sea, Thermaikos Gulf concentrates the second highest fishing effort of trawlers in the Aegean Sea (GSA 22). In total, 47.6% of trawling in the Aegean takes place in Thermaikos Gulf and Thracian Sea. As far as purse-seiners are concerned, 20.23% of purse-seining in the Aegean Sea (GSA 22) takes place in Thermaikos Gulf.

8.4.2 Causes of discarding

All *métiers* used in Thermaikos Gulf share the same market and regulation causes for discarding. The general fisheries regulations for the Greek seas, based on the European legislation, apply in Thermaikos Gulf. For example, Minimum Landing Size (MLS) is the main reason for discarding hake*Merluccius merluccius*, red mullet *Mullus barbatus* and cuttlefish *Sepia* spp., while low market demand is the reason of discarding spottail mantis shrimp *Squilla mantis* and other crustaceans. Discarding practices are influenced by fishing processes and fishers' decision making, which, at least in Greek waters, is affected by several factors, including weather conditions, economic pressure, market demands, fishing strategies, skipper's knowledge and skills (Tsitsika and Maravelias 2006).

Based on the classificationby Eliasen and Christensen (2012), the factors affecting discards in the Mediterranean may be divided into four categories: (a) natural conditions that include species composition and abundance, resource availability, species invasions, and environmental factors (depth, seabed, productivity); (b) community (haul duration, sorting practices, soak time); (c) states and regulations that include technical measures (gear selectivity), spatiotemporal closures, MLS, control mechanisms; and (d) market influence that includes economic value of species (damaged, unwanted catch), resource use related to socio-economic factors, storage capacity of the vessel and sortingcapacity of the crew (Eliasen and Christensen 2012). These factors often act in synergistic manner that may not be straightforward to disentangle, especially in multispecies fisheries, which is the case in the Mediterranean (Tsagarakis et al. 2014). As a result,high regional, seasonal, and interannual fluctuations are observedeven within the same fishing gear (Tsagarakis et al. 2014).

8.4.3 Effects of discarding

The survival rates of discardshave not been evaluated in the northern Aegean Sea. With the exception of some species, survivability is considered to be very low in the area.There is a study on the survival rates of three fish species, the brown comber (*Serranus hepatus*), black goby (*Gobius niger*) and annular seabream (*Diplodus annularis*), after their escape from a 40 mm stretched diamond mesh polyethylene (PE) codend that has been conducted in eastern Aegean Sea (Duzbastilar et al. 2010). With very short (15 in duration) hauls, the mean survival mean survival percentages of open codend and experimental cages were found to be 97.1% and 98.3% for brown comber, 69.0% and 77.2% for black goby, and 97.5% and 98.6% for annular seabream respectively. The "Choke effect" is not applicable in any of Thermaikos Gulf fisheries because, contrary to several north Atlantic fisheries, there are no quota restrictions in the study area.

Although the ecological effects of discards have not yet been evaluated in Thermaikos Gulf, the cascading effect across the marine food wed is expected to be high (e.g. seabirds: Arcos and Oro 2002) at all level of biological organization (Sarda et al. 2015). Data on the effect of purse-seine discards exists only for Thracian Sea (Tsagarakis et al. 2012), while the general effects of discards have been recently reviewed (Tsagarakis et al. 2014).The potential impacts of discard landing obligation may be dramatic for theMediterranean Sea,where a large part of discards is already composedof juvenile fishes with body sizes smaller than theminimum landing sizes and of invertebrates (Sarda et al. 2015).

The economic, operational and technical costs associated with the manipulation and storage of discards on board may be high (Sarda et al. 2015). These costs may inclue additional crew and storage costs and landings costs (boxes, storage, ice). The monitoringand controlling costs to preventfishers from discarding when at seaarealso expected to be high (Sarda et al. 2015).

8.4.4 Discard data

8.4.4.1 Sampling

Discard data are collected, by observers onboard, under the Discard Sampling Program funded by the Data Collection Framework (EC 2008). The sampling design is stratified by fleet, area and depth. Trips are the primary sampling unit, and sample selection is non probability based; trips have been selected based on availability and suitability of the vessel.

Table 18: Greek otter bottom trawl (OTB_DES_>=40_0_0) in Thermaikos Gulf: number of vessels, days at sea (refers to the last trimester of 2013), and sampling coverage for 2013 based on the DCF data.

TRAWLERS (OTB)	**No vessels**	**Total days at sea**
Total	58	2004
Sampled	25	32
Sampling coverage (%)	43%	1.6%

Table 19: Greek purse seiners (PS_SPF_>=14_0_0) in Thermaikos Gulf: number of vessels, days at sea (refers to the last trimester of 2013), and sampling coverage for 2013 based on the DCF data.

PURSE SEINERS (PS)	**No vessels**	**Total days at sea**
Total	29	1134
Sampled	9	32
Sampling coverage (%)	31%	2.8%

Table 20: Greek small scale coastal boatsusing various gears in Thermaikos Gulf: number of vessels, days at sea (refers to the last trimester of 2013), and sampling coverage for 2013 based on the DCF data.

	No vessels	Total days at sea
Total	1373	-
Sampled	32	250
Sampling coverage (%)	2.33%	-

8.4.4.2 Discard rates and levels

The most abundant species in the bottom trawl catches in Thermaikos Gulf are red mullet *Mullus barbatus*, cuttlefish *Sepia* spp., spottail mantis shrimp *Squilla mantis*, caramote prawn *Melicertus kerathurus*, deep-water rose shrimp *Parapenaeus longirostris*, musky octopus *Eledone* spp., anglerfish *Lophius* spp., European hake *Merluccius merluccius*, spotted flounder *Citharus linguatula*, and octopus *Octopus* spp. (Apostolidis et al. 2013). Red mullet *Mullus barbatus* and surmullet *Mullus surmuletus*, caramote prawn, deep-water rose shrimp, European hake, cuttlefish and octopus are the main target species of the trawl fishery in Thermaikos Gulf.

Overall 191 species (137 fishes, 29 crustaceans and 25 cephalopods) were collected in the northern Aegean Sea by the experimental bottom trawl survey (MEDITS) in 2013 (DCF dataset). Species with the highest biomass (kg/km^2) rates were: European anchovy *Engraulis encrasicolus* (220.32 kg/km^2), *Illex coindetti* (87.95 kg/km^2), European sardine *Sardina pilchardus* (51.43 kg/km^2), blue whiting *Micromesistius poutassou* (38.03 kg/km^2), Atlantic horse mackerel *Trachurus trachurus* (34.06 kg/km^2), European hake *Merluccius merluccius* (31.72 kg/km^2), deep-water rose shrimp*Parapenaeus longirostris* (25.44 kg/km^2), red mullet *Mullus barbatus* (24.05 kg/km^2), argentine *Argentina sphyraena* (23.39 kg/km^2) andsilver scabbardfish *Lepidopus caudatus* (23.22 kg/km^2).

Anchovy *Engraulis encrasicolus*, sardine *Sardina pilchardus* and Atlantic chub mackerel *Scomber colias* are the main target species of purse seines in the area.

The small-scale coastal fleet of Thermaikos Gulf targets a wide variety of species some of which are also targeted by the trawling fleet (e.g. red mullet and surmullet, and caramote prawn) and one by the purse seiners (European sardine).

The discarded species and the discards (D) to catch (C) ratio per gear and species in northern Aegean Sea (data from DCF 2013) are shown in Table 21. Onboard observations to all gears/vessels were confined to the last trimester of 2013 (October to December).

Table 21: Discards (D)to catch (C) ratio per gear and species in northern Aegean Sea (data from DCF 2013).Ratios higher than 10% are shown in bold.

Gear	Species	D/C Ratio
GNS	*Boops boops*	0.0545

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

Gear	Species	D/C Ratio
GNS	***Eutrigla gurnardus***	**0.3216**
GNS	*Loligo vulgaris*	0.0006
GNS	***Lophius budegassa***	**0.1091**
GNS	***Melicertus kerathurus***	**0.1176**
GNS	*Merluccius merluccius*	0.0267
GNS	*Mullus barbatus*	0.0045
GNS	*Mullus surmuletus*	0.0142
GNS	*Nephrops norvegicus*	0.0438
GNS	***Pagellus erythrinus***	**0.1260**
GNS	*Parapenaeus longirostris*	0.0263
GNS	*Sardina pilchardus*	0.0474
GNS	*Scomber scombrus*	0.0056
GNS	*Spicara smaris*	0.0034
GNS	*Trachurus mediterraneus*	0.0995
GNS	***Trachurus trachurus***	**0.2677**
GNS	***Trigla lucerna***	**0.3297**
GTR	*Boops boops*	0.0378
GTR	***Eledone moschata***	**0.7370**
GTR	***Eutrigla gurnardus***	**0.2593**
GTR	*Lophius budegassa*	0.0351
GTR	***Merluccius merluccius***	**0.1493**
GTR	*Mullus barbatus*	0.0047
GTR	*Mullus surmuletus*	0.0124
GTR	*Pagellus erythrinus*	0.0439
GTR	***Raja miraletus***	**0.2356**
GTR	*Sepia officinalis*	0.0166

Gear	Species	D/C Ratio
GTR	*Trachurus mediterraneus*	0.0722
GTR	***Trachurus trachurus***	**0.6429**
GTR	*Trigla lucerna*	0.1014
LLS	*Boops boops*	0.0789
LLS	*Pagellus erythrinus*	0.0092
LLS	*Sparus aurata*	0.0182
LLS	*Trachurus mediterraneus*	0.0565
OTB	***Boops boops***	**0.8430**
OTB	*Eledone moschata*	0.0287
OTB	***Engraulis encrasicolus***	**0.9674**
OTB	***Eutrigla gurnardus***	**0.8966**
OTB	*Loligo vulgaris*	0.0131
OTB	*Lophius budegassa*	0.0389
OTB	*Lophius piscatorius*	0.0069
OTB	*Merluccius merluccius*	0.0362
OTB	*Mullus barbatus*	0.0064
OTB	*Mullus surmuletus*	0.0326
OTB	*Nephrops norvegicus*	0.0169
OTB	*Pagellus erythrinus*	0.0755
OTB	***Parapenaeus longirostris***	**0.1100**
OTB	***Raja miraletus***	**0.1204**
OTB	***Sardina pilchardus***	**0.9730**
OTB	***Scomber scombrus***	**0.2408**
OTB	*Sepia officinalis*	0.0287
OTB	*Solea solea*	0.0110
OTB	***Spicara smaris***	**0.8974**

Gear	Species	D/C Ratio
OTB	***Trachurus mediterraneus***	**0.9416**
OTB	***Trachurus trachurus***	**0.8083**
OTB	*Trigla lucerna*	0.0882
PS	*Boops boops*	0.0001
PS	***Eledone moschata***	**0.2000**
PS	*Engraulis encrasicolus*	0.0001
PS	*Loligo vulgaris*	0.0320
PS	*Melicertus kerathurus*	0.0655
PS	***Merluccius merluccius***	**0.2000**
PS	***Mullus barbatus***	**0.3347**
PS	*Pagellus erythrinus*	0.1003
PS	***Parapenaeus longirostris***	**1.0000**
PS	*Sepia officinalis*	0.0870
PS	***Spicara smaris***	**0.9615**
PS	*Trachurus mediterraneus*	0.0760
PS	*Trachurus trachurus*	0.0628
PS	*Trigla lucerna*	0.0909

According to recent research in Thermaikos Gulf (Apostolidis et al. 2013), in which samples were collected between November 2012 and March 2013, trawl discard to catch ratios in Thermaikos Gulf are different (Table 22) compared to those reported by DCF, indicating a potential seasonal effect (Tsagarakis et al. 2014).

Table 22: Trawling discards (D) to catch (C) ratio per species in Thermaikos Gulf (data from Apostolidis et al. 2013).Ratios higher than 10% are shown in bold.

Gear	Species	D/C Ratio
OTB	*Mullus barbatus*	0.027
OTB	***Sepia* spp.**	**0.324**
OTB	***Squilla mantis***	**0.353**

Gear	Species	D/C Ratio
OTB	*Melicertus kerathurus*	0.009
OTB	***Parapenaeus longirostris***	**0.485**
OTB	*Eledone* spp.	0.087
OTB	*Lophius* spp.	0.001
OTB	*Merluccius merluccius*	0.057
OTB	***Citharus linguatula***	**0.821**

8.4.5 EwE Modelling of the Thermaikos Gulf

The EwE model will cover Thermaikos Gulf (NW Aegean Sea), one of the most important fishing grounds in the eastern Mediterranean and home-port of the majority of the trawling and purse-seine fleet. In total, 40 functional groups have been previously used to model the Thracian Sea in NE Aegean (Tsagarakis et al. 2010). The same groups will form the basis for modeling Thermaikos Gulf but slight modifications might be required. These groups included low trophic level components (2 groups), detritus and discards, commercial (6 groups) and non- commercial invertebrates (5 groups) and fish (22 groups), as well as dolphins, turtles and seabirds (Table 23). Annual landings per species and fleet (small-scale costal fisheries, trawlers, purse-seiners) will be based on two alternative fisheries datasets (official landings and reconstructed catches, which includes discarded and unreported catches: Moutopoulos et al. 2015).

Table 23: Description of functional groups species composition in EwE eastern Mediterranean case study. Single species groups are italicized.

Low trophic	**Invertebrates**	**Fish**	
Phytoplankton	Mesozooplankton	Red mullets	*Loggerhead*
Ciliates	Macrozooplankton	Anglerfish	Seabirds
	Jellyfish	Flatfishes	Dolphins
Detritus	Small benthic	Other gadiforms	
Discards	Polychaetes	*Hake*	
	Shrimps	Demersal fishes 1	
	Crabs	Demersal fishes 2	
	Norway lobster	Demersal fishes 3	
	Benthic invertebrates	Demersal fishes 4	
	Octopuses & cuttlefish	Benthopelagic fishes	
	Squids	Picarels and bogue	
		Demersal sharks	
		Demersal rays & skates	
		Juvenile anchovy	
		Adult anchovy	

		Juvenile sardine	
		Adult sardine	
		Horse mackerels	
		Mackerels	
		Other smallpelagic	
		Mediumpelagic fishes	
		Large pelagic fishes	

Species-specific and fleet-specific discards to market able ratios will be used to estimate the amount of total discards generated per annum. The detailed composition of the invertebrate part of the discarded catch per segment of the small-scale coastal fisheries, trawling and purse-seining fleet will be acquired from the literature (Voultsiadou et al. 2011).

8.4.6 References

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