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Fish assemblages in the trawling grounds of Northeastern Mediterranean: Comparison between the 1980s and 2020s

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Abstract

Since the opening of the Suez Canal, the Eastern Mediterranean has been continuously affected by the influx of non-indigenous species (NIS), leading to significant changes in species composition. In this study, we focus on the temporal changes in marine teleost fish communities within one of the most heavily invaded shelf ecosystems. To examine changes in species assemblages, we integrated historical seasonal trawl data from the 1980s with recent data collected in 2022 along the Northeastern Mediterranean coast at depths of 0–25 m, 25–50 m, and 50–100 m. As a result, we identified 130 fish species, consisting of 37 NIS and 93 native species. Cluster analysis and Non-metric Multidimensional Scaling (NMDS) results revealed three main groups: a shallow water group, a deeper water group, and a western group, along with additional groups exhibiting sporadic occurrences. The western group, influenced by the presence of *Posidonia oceanica* meadows, has consistently been dominated by native biomass. However, the ratio of NIS to the total number of species has notably increased since the 1980s. The shallow water group, considered Por's "Lessepsian Province", is predominantly composed of NIS biomass and spans a depth range of 7 to 60 meters. In contrast, the deeper water group, which extends up to 82 meters, has maintained a relatively stable community dominated by native biomass over the years. However, since the 1980s, there has been a recorded increase in the contribution of NIS biomass and the overall proportion of NIS in the total species count within this group. Significant differences in community structure were correlated with depth and the spatially defined subregions within the study area. This study elucidates the dynamic nature of species assemblages in the continental shelf of the Northeastern Mediterranean and emphasizes the need for continuous monitoring to understand the ongoing transformations in these heavily impacted regions.

Keywords: NIS; composition; fish assemblages; indicator species.

Introduction

Marine ecosystems have undergone significant changes due to the spread of non-indigenous species (NIS) (Costello *et al*., 2010). In their established habitats, NIS disrupt community structures, jeopardize ecosystem functioning, and consequently impact human health and the economy (Golani, 2010; Vilà *et al*., 2011). The Mediterranean Sea, recognized as a hotspot for NIS introductions, hosts over a thousand NIS, primarily introduced through the Suez Canal, which was constructed in 1869 (Azzurro *et al*., 2022a, b). The opening of the canal led to the migration of tropical species (Por, 1978) into the Mediterranean (Ben-Tuvia, 1964; Galil, 2023). Today, the canal remains an essential pathway for the migration of NIS (Galil, 2023). As a result of this continuous influx, the number of NIS in the Mediterranean has progressively increased (Belmaker *et al*., 2009; Gücü *et al*., 2010; Arndt *et al*., 2018; Azzurro *et al*., 2022b; Galil, 2023). This spread is particularly pronounced in the Eastern Mediterranean, where unsaturated ecological niches (Galil, 2023; Oliverio & Taviani, 2003) and various anthropogenic stressors, such as pollution, habitat degradation, and climate change, enhance the region's vulnerability to the influx of NIS (Bilecenoğlu, 2010; Gücü *et al*., 2010; Lejeusne *et al*., 2010; Coll *et al*., 2012; Katsanevakis *et al*., 2014; Barange *et al*., 2018). Consequently, significant transformations in marine biota have been documented, with many NIS becoming major components of the ecosystem (Mavruk & Avsar, 2008; Bilecenoğlu, 2010; Gücü *et al*., 2010; Ok, 2012; Yemisken *et al*., 2014; Öndes & Ünal, 2023). Once established, the impacts of NIS are challenging or impossible to reverse (Galil, 2023). Therefore, understanding the mechanisms that drive their spread and establishment is essential for developing effective management strategies.

One key hypothesis concerning NIS spread suggests that competition with NIS drives the displacement of native fauna from their geographical ranges, posing a significant threat to biodiversity (Breithaupt, 2003). For example, the decline of native herbivorous fish *Sarpa salpa* in Lebanese waters has been attributed to competition from the NIS herbivore *Siganus rivulatus (*Bariche *et al*. 2004). Similarly, studies conducted in Türkiye and Greece have documented how intensive grazing by non-indigenous siganids disrupts macrophyte development, resulting in barren areas (Azzurro *et al*., 2007; Katsanevakis *et al*., 2020). This grazing effect cascades through ecosystems, altering benthic assemblages (Sala *et al*., 2011) and reducing species richness and biomass of carnivorous fish, particularly in warmer regions (Vergés *et al*., 2014). However, some studies suggest that interactions are not always detrimental. Giakoumi (2014) found a positive relationship between the abundance of *Siganus luridus* and native thermophilic *Sparisoma cretense*, indicating the potential for facilitative interactions. In certain cases, declines in native species attributed to NIS may instead be linked to other factors. For instance, while competitive exclusion has been suggested between native *Merluccius merluccius* and NIS *Saurida lessepsianus* (Oren, 1957; Ben-Yami & Glaser, 1974), Gücü & Bingel (2011) argued that hydrographic conditions in the Southern Türkiye could better explain fluctuations in *M. merluccius* populations. Other studies highlight the significance of trophic flexibility and compatibility of pre-existing traits in facilitating NIS establishment (Eşkinat *et al*., 2023; Tüzün & Gücü, 2023, 2024). Beyond their ecological impacts, NIS exert multifaceted socio-economic impacts (Bariche, 2012; Christidis *et al*., 2024). Some fish species, such as *S. lessepsianus,* shrimps and prawns, such as *Penaeus japonicus* and *Penaeus semisulcatus,* have become commercially valuable and are now actively targeted by fishers (Duruer *et al*., 2008; Galanidi *et al*., 2018). Others, like *Equulites klunzingeri* and *Pomadasys stridens,* have reached high biomass levels, likely displacing native competitors and altering trophic dynamics (Arndt *et al*., 2015; Mavruk *et al*., 2017). Meanwhile, species such as *Lagocephalus sceleratus, Plotosus lineatus,* and *Rhopilema nomadica* may pose significant threats to human health and local fisheries operations (Christidis *et al*., 2024). Regardless of the debate surrounding their impact on native fauna, there is consensus that NIS distribution is progressing westward (Golani, 2021; Azzurro *et al*., 2022b) and expanding into deeper waters (Gücü *et al*., 2010; Edelist *et al*., 2013). Faunal analyses by depth zones reveal that NIS generally dominate at shallower depths, although species-specific variations exist (Gücü *et al*., 2010; Özyurt *et al*., 2018). While a substantial body of literature addresses non-indigenous fish in the Eastern Mediterranean Sea (Çınar *et al*., 2021; Golani *et al*., 2021; Azzurro *et al*., 2022b), relatively few studies directly examine their ecological impacts (Kalogirou *et al*., 2012a; Katsanevakis *et al*., 2014; Solanou *et al*., 2023). Furthermore, much of the discussion has centered on specific NIS species (Giakoumi, 2014; Katsanevakis *et al*., 2020; Eşkinat *et al*., 2023; Tüzün & Gücü, 2023), with less focus on broader patterns of change.

The Eastern Mediterranean, recognized as one of the fastest warming regions within the Mediterranean basin, has received significant attention (MedECC, 2020). However, its northeastern part remains understudied regarding faunal composition dynamics (Gücü & Bingel, 1994; Edelist *et al*., 2013; Mavruk *et al*., 2017; Arndt *et al*., 2018; de Meo *et al*., 2018). Existing research often provides fragmented insights, highlighting the importance of utilizing historical data (Gücü *et al*., 2010; Edelist *et al*., 2013; Arndt *et al*., 2018). To address these gaps, we integrated historical and newly collected scientific bottom trawl data, both obtained following the same sampling protocol. This approach enables us to (i) describe the composition of demersal fish assemblages along the continental shelf of the Turkish coast in the Northeastern Mediterranean, (ii) test whether non-indigenous fish assemblages have expanded into deeper strata and westward regions, and (iii) identify the species driving compositional differences.

Materials and Methods

Study Area and Sampling Data

The study area is located in the Northeastern Mediterranean Basin, encompassing the coastline from Iskenderun Bay in the east to Cape Anamur in the west. Region-wide bottom trawl surveys were conducted in autumn 1983, spring 1984, autumn 1984, spring 2022, and autumn 2022. Details of the sampling procedure, including coordinates, dates, and times, are provided in Table A1. Data were collected by RV/Lamas of METU-IMS, using the same trawl net design (locally called the Ottoman) in all surveys and applying the same sampling protocol (applied by Gücü & Bingel, 1994) throughout the study. The covered coastline was divided into three subregions to evaluate the westward spread of non-indigenous fish. These subregions were Iskenderun Bay, Mersin Bay, and the coastal strip between the Cape İncekum (Göksu River) and Cape Anamur. To represent different faunal characteristics of the basin, three hauls from fixed depth strata (0-25 m, 25-50 m, 50-100 m) were sampled in each subregion. Since the commercial fishing fleet did not operate in depth strata deeper than 100 meters in the 1980s, the deepest areas sampled in this study is limited to 100 meters. The standard haul duration was 30 minutes; operations were cut short due to rocky bottoms, mechanical issues, or static gear. In such cases, hauls were deemed valid if at least half the planned duration was completed. In borderline cases, the survey leader assessed validity based on operational judgment and data quality. All sampling was conducted during daylight hours. Elasmobranchs were excluded from the community analysis due to their low catchability, stemming from their large body size relative to the teleosts targeted by the sampling gear and their sporadic occurrence in demersal trawl samples. When encountered, they were typically represented by a small number of large individuals. This combination of rarity and high individual weight exerted a disproportionate influence on the biomass-based analysis by introducing noise into the clustering results. In particular, their inclusion led to the formation of additional, analytically unstable clusters that masked broader patterns in overall community structure. Preliminary analyses comparing results with and without elasmobranchs confirmed that their inclusion distorted cluster formation and reduced interpretability. To ensure consistency and better capture general trends in the fish assemblage, we therefore restricted our analysis to teleost species. The catch from each haul was sorted and taxonomically identified to the species level, and the total weight of each species was measured on board.

Statistical Analysis

The trawlable biomass index was performed by estimating the catch per unit area (CPUA) (Sparre & Venema, 1998). To estimate CPUA, the catch weight was divided by the area swept during the haul. The swept area for each haul was estimated using the following formula:

$$A = \mathrm{D}*\mathrm{hr}*\mathrm{X}_2$$

'D' is the distance covered, 'hr's the head rope length, and 'X_2'is a fraction of the head rope length. Drawing on Pauly (1980), a head rope length fraction (X_2) of 0.5 was used in this study. The catchability coefficient of the trawl net is assumed as (q = 1). The length of the head rope of the trawl net used was 23.7. The distance covered during each haul was calculated in the RStudio environment (Posit Team, 2024) using the "distance" function from the "argosfilter" package (version 0.7) within R (R Core Team, 2024).

To ascertain fish assemblages, CPUA values were log-transformed ($\log_{10}(X+1)$) to minimize the impact of occasional high biomass values of NIS species and reduce skewness.

The transformed data were organized into a matrix, with species as columns and station IDs as rows. After matrix construction, Bray-Curtis dissimilarities were calculated based on the log-transformed data (Baselga, 2013). Average linkage hierarchical clustering algorithms were used to identify groups of fish communities based on their species composition. These groupings were then interpreted based on the native or NIS status of the species. Non-metric multidimensional scaling (NMDS) was also applied to provide an alternative perspective and facilitate interpretation of the results in conjunction with hierarchical cluster analysis (Hong & Zhinan, 2003). For the first period, clusters were identified at a 50% dissimilarity level, resulting in five distinct clusters. This number of clusters was then fixed and applied to subsequent periods for consistency in comparison (Kindt & Coe, 2005). The obtained clusters were coded and extracted, and the group codes of corresponding stations were mapped using the QGIS software (Version 3.40) (QGIS Development Team, 2024). To evaluate the significance of clusters in terms of species composition, Permutational Multivariate Analysis of Variance (PERMANOVA) was used, as the data did not meet the parametric criteria (Anderson, 2001). However, this test does not distinguish whether the significance arises from differences in the centroids or from heterogeneity in dispersion among the groups. Therefore, the PERMDISP (a multivariate extension of Levene's test) is used to calculate the distance from each sampling unit to the centroid for its grouping factor level (Anderson *et al*., 2006). Bias adjustment was set to true due to the unequal number of samples in clusters (Anderson, 2006). These distances were examined with PERMUTEST to test differences. Clusters formed by data from a single station are not included in the analysis due to the assumptions of the statistical tests. Similarly, PERMDISP and two-way PERMANOVA were applied to test differences among depth strata and subregions.

To facilitate the interpretation of compositional differences, Similarity percentage analysis (SIMPER) was used to identify the species that contributed most to the average Bray-Curtis dissimilarity between clusters. Additionally, Indicator Species Analysis (ISA) was also performed to determine which species are associated with or indicative of particular assemblages (Dufrêne & Legendre, 1997).

All statistical analyses were conducted in R software v.4.3.3 (R Core Team, 2024) using the RStudio interface (Posit team, 2024). Tests were performed using the package 'vegan' (Oksanen *et al*., 2023) and package 'indicspecies' (De Cáceres & Legendre, 2009). Graphs were produced using package 'ggplot2' (Wickham, 2016).

Results

A total of 249 hauls were performed throughout this study, capturing 130 distinct teleost fish species from 54 families along the continental shelf of the Northeastern Mediterranean Sea (see Table 1). This dataset included 81 species from 44 families recorded in the 1980s and 118 species from 50 families recorded in the 2020s. The ratio of NIS to the total reported fish species increased from 19.75% in the 1980s to 29.66% in the 2020s. The highest number of NIS was recorded in autumn 2022 (Table A2, note that Tables A1-A20 can be found in the Appendix). Over the study period, total CPUA exhibited a marked increase, particularly in recent years. In the early 1980s, total CPUA ranged from 753 to 972 kg/km², while by 2022, it had risen to 2,928 kg/km² in the spring and 2,446 kg/km² in the autumn (Fig. 1, Table A2). This overall increase was primarily driven by NIS, whose CPUA rose sharply, while the CPUA of native species declined. Notably, the CPUA of NIS in spring 2022 was approximately 14 times higher than that documented in spring 1984 (Fig. 1). Average linkage clustering of the samples revealed the occurrence of three main discernible assemblages: a shallow water group, a deeper water group and a western group, with additional groups exhibiting sporadic occurrences (Fig. 2). Generally, NMDS ordinations effectively reflected the dendrogram's grouping, providing a reliable representation with moderate stress levels (Fig. A1, A, B, C, D, E). While the total CPUA remained

Table 1. The list of teleost species recorded along the continental shelf area of the Northeastern Mediterranean Sea. The origin of each species is given in parentheses. "NIS" represents non-indigenous species, and" "N" represents the native species.

Valid name	Family	Valid name	Family
Alosa fallax (N)	Alosidae	*Muraena helena* (N)	Muraenidae
Sardina pilchardus (N)		*Nemipterus randalli* (NIS)	Nemipteridae
Apogonichthyoides nigripinnis (NIS)	Apogonidae	*Echelus myrus* (N)	Ophichthidae
Cheilodipterus novemstriatus (NIS)		*Phycis blennoides* (N)	Phycidae
Jaydia queketti (NIS)		*Phycis phycis* (N)	
Jaydia smithi (NIS)		*Pomatomus saltatrix* (N)	Pomatomidae
Ostorhinchus fasciatus (NIS)		*Sparisoma cretense* (N)	Scaridae
Atherinomorus lacunosus (NIS)	Atherinidae	*Argyrosomus regius* (N)	Sciaenidae
Balistes capriscus (N)	Balistidae	*Umbrina cirrosa* (N)	
Blennius ocellaris (N)	Blenniidae	*Scomber colias* (N)	Scombridae
Microlipophrys dalmatinus (N)		*Pterois miles* (NIS)	Scorpaenidae
Arnoglossus laterna (N)	Bothidae	*Scorpaena notata* (N)	
Arnoglossus thori (N)		*Scorpaena porcus* (N)	
Bothus podas (N)		*Scorpaena scrofa* (N)	
Callionymus filamentosus (NIS)	Callionymidae	*Serranus cabrilla* (N)	Serranidae
Callionymus maculatus (N)		*Serranus hepatus* (N)	
Alepes djedaba (NIS)	Carangidae	*Serranus scriba* (N)	
Caranx crysos (N)		*Siganus luridus* (NIS)	Siganidae
Caranx rhonchus (N)		*Siganus rivulatus* (NIS)	
Scyris alexandrina (N)		*Sillago suezensis* (NIS)	Sillaginidae
Seriola dumerili (N)		*Microchirus ocellatus* (N)	Soleidae
Trachurus mediterraneus (N)		*Monochirus hispidus* (N)	
Trachurus trachurus (N)		*Solea solea* (N)	
Macroramphosus scolopax (N)	Centriscidae	*Boops boops*(N)	Sparidae
Cepola macrophthalma (N)	Cepolidae	*Dentex dentex* (N)	
Champsodon nudivittis (NIS)	Champsodontidae	*Dentex gibbosus* (N)	
Citharus linguatula (N)	Citharidae	*Dentex macrophthalmus* (N)	
Conger conger (N)	Congridae	*Diplodus annularis* (N)	
Cynoglossus sinusarabici (NIS)	Cynoglossidae	*Diplodus cervinus* (N)	
Dactylopterus volitans (N)	Dactylopteridae	*Diplodus puntazzo* (N)	
Sardinella aurita (N)	Dorosomatidae	*Diplodus sargus* (N)	
Sardinella maderensis (N)		*Diplodus vulgaris* (N)	
Dussumieria elopsoides (NIS)	Dussumieriidae	*Lithognathus mormyrus* (N)	
Etrumeus golanii (NIS)		*Oblada melanurus* (N)	
Remora remora (N)	Echeneidae	*Pagellus acarne* (N)	
Engraulis albidus (N)	Engraulidae	*Pagellus bogaraveo* (N)	
Engraulis encrasicolus (N)		*Pagellus erythrinus* (N)	
Epinephelus aeneus (N)	Epinephelidae	*Pagrus auriga* (N)	
Epinephelus marginatus (N)		*Pagrus pagrus* (N)	
Fistularia commersonii (NIS)	Fistulariidae	*Sparus aurata* (N)	
Fistularia petimba (NIS)		*Spicara flexuosum* (N)	
Deltentosteus quadrimaculatus (N)	Gobiidae	*Spicara maena* (N)	
Gobius niger (N)		*Spicara smaris* (N)	
Oxyurichthys papuensis (NIS)		*Spondyliosoma cantharus* (N)	
Pomadasys incises (N)	Haemulidae	*Sphyraena chrysotaenia* (NIS)	Sphyraenidae
Pomadasys stridens (NIS)		*Sphyraena sphyraena* (N)	

Continued

Table 1 continued

Valid name	Family	Valid name	Family
Sargocentron rubrum (NIS)	Holocentridae	*Hippocampus guttulatus* (N)	Syngnathidae
Coris julis (N)	Labridae	*Hippocampus hippocampus* (N)	
Pteragogus trispilus (NIS)		*Syngnathus acus* (N)	
Symphodus mediterraneus (N)		*Saurida lessepsianus* (NIS)	Synodontidae
Symphodus roissali (N)		*Synodus saurus* (N)	
Symphodus rostratus (N)		*Pelates quadrilineatus* (NIS)	Terapontidae
Symphodus tinca (N)		*Lagocephalus sceleratus* (NIS)	Tetraodontidae
Xyrichtys novacula (N)		*Lagocephalus suezensis* (NIS)	
Equulites klunzingeri (NIS)	Leiognathidae	*Lagocephalus spadiceus* (NIS)	
Equulites popei (NIS)		*Torquigener hypselogeneion* (NIS)	
Merluccius merluccius (N)	Merlucciidae	*Trachinus draco* (N)	Trachinidae
Stephanolepis diaspros (NIS)	Monacanthidae	*Trichiurus lepturus* (N)	Trichiuridae
Chelon auratus (N)	Mugilidae	*Chelidonichthys lastoviza* (N)	Triglidae
Chelon saliens (N)		*Chelidonichthys lucerna* (N)	
Mugil cephalus (N)		*Lepidotrigla cavillone* (N)	
Planiliza carinata (NIS)		*Uranoscopus scaber* (N)	Uranoscopidae
Mullus barbatus (N)	Mullidae	*Zeus faber* (N)	Zeidae
Mullus surmuletus (N)			
Parupeneus forsskali (NIS)			
Upeneus moluccensis (NIS)			
Upeneus pori (NIS)			

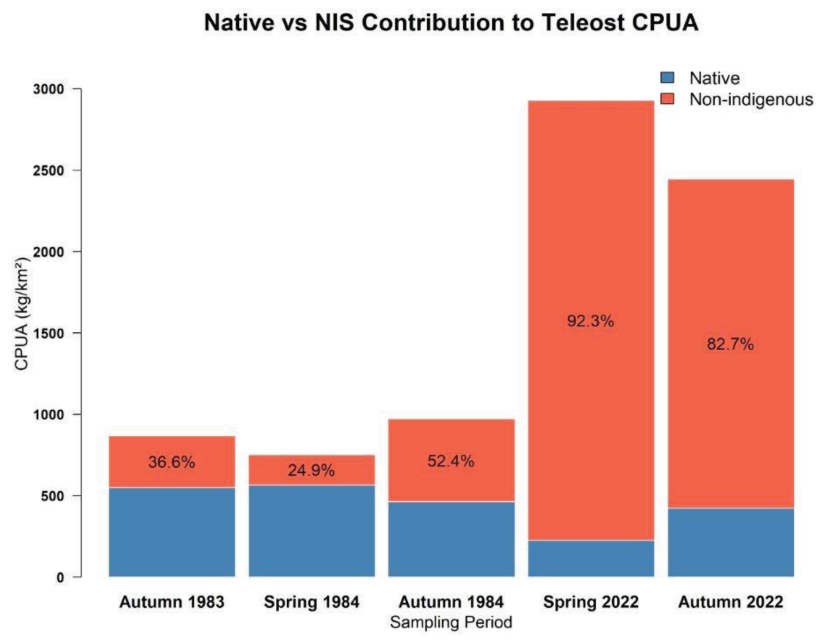

Fig. 1: Total CPUA (kg/km²) of teleost fishes per sampling period, partitioned into native species and NIS based on their proportional contributions (%). Bar height represents the total CPUA, and bar segments display group-specific shares.

relatively stable in the deeper group, the contribution of NIS to CPUA increased in the 2020s. In the western group, total CPUA in the 2020s was generally lower than in the 1980s, except in spring 1984. However, the proportion of NIS CPUA was higher in the 2020s than the 1980s, except in 1983. The only group that exhibited an overall increase in CPUA was the shallow water group, driven by a substantial rise in NIS biomass, which exceeded 90% of the CPUA. Temporal changes in the main groups are visualized in Figure 3. A summary of the overall patterns is provided in Appendix Figure A1, whereas Table A3 presents detailed group-specific values across sampling periods. These details are further elaborated for each sampling period in the following subsections. The

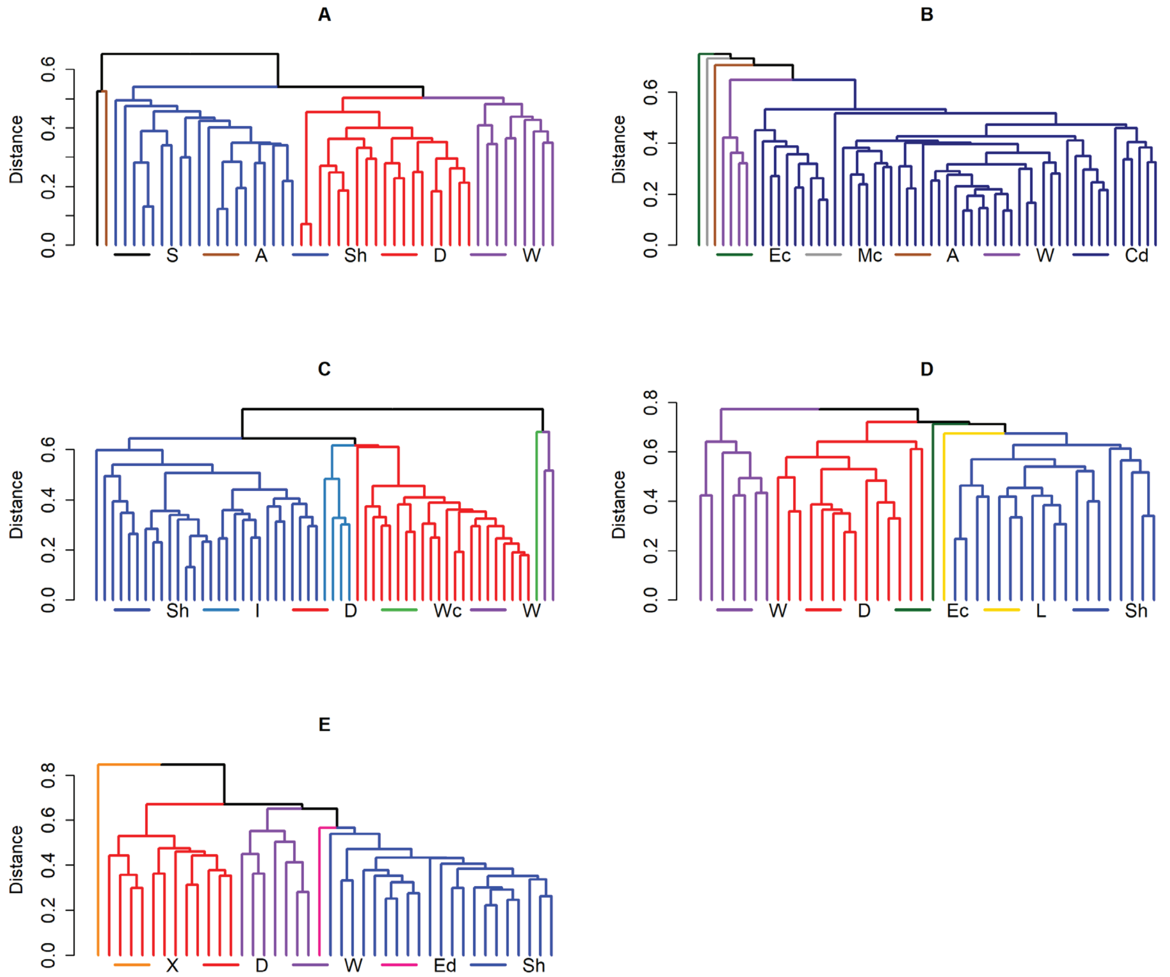

Fig. 2: Dendrograms illustrating the similarity levels among 5 clusters for autumn 1983 (A), spring 1984 (B), autumn 1984 (C), spring 2022 (D), autumn 2022 (E). Abbreviations: S = Seyhan River, A = Akyayan Lake, Sh = Shallow, D = Deep, W = West of Mersin Bay, Ec = Eastern coast, Mc = Mersin coast, Cd =Coastal-Deep, Wc =Western coastal, L = Lamas, Ed = Deep in the east, X = No common feature.

significance of PERMUTEST and PERMANOVA results indicated that, particularly for autumn 1983 the dispersion within the depth strata might be more critical than their centroids regarding community composition. Conversely, for spring 1984, autumn 1984, spring 2022 and autumn 2022, the lack of significance in dispersion versus significant PERMANOVA results indicates statistical differences in the fish community compositions among three depth strata (Table A5 and Table A6). Moreover, the homogeneity of dispersions, together with the significant PERMANOVA results across all sampling periods, indicates notable differences in community composition among the clusters and subregions (except spring 1984 for subregions) (Table A5 and Table A6). According to the SIMPER results, the highest level of dissimilarity among groups was observed in spring 2022 (Fig. A3). While the significant contribution of NIS to average dissimilarity markedly increased from the 1980s to the 2020s, that of native species remained relatively stable across most group comparisons, except for a notable decline observed between the Shallow and Western groups in the 2020s.

Autumn 1983

In autumn 1983, 66 teleost fish species were documented, with 53 native species contributing 63.4% of the total CPUA (Fig. 1, Table A2). Table A4 presents the top fifteen species representing the highest percentages of total biomass in each subregion. In this period, the cut-off dissimilarity level for five clusters was 50% (see Fig. 2). Upon closer examination of the dendrogram, it was observed that initially, two branches emerged. The first branch consisted of two isolated groups labelled S (Seyhan River) and A (Akyayan Lake), each consisting of a single station. The second branch comprised groups labelled Sh (Shallow), D (Deep) and W (West of Mersin Bay) (Fig. 2). The group code of each station is depicted on a map (Fig. 4).

Shallow (8-58.5m)

The stations categorized under this group encompass waters within the 8.5 m to 58.5 m isobaths, extending from the easternmost part of Iskenderun Bay to near the Göksu River mouth. A total of 52 teleost fish species were

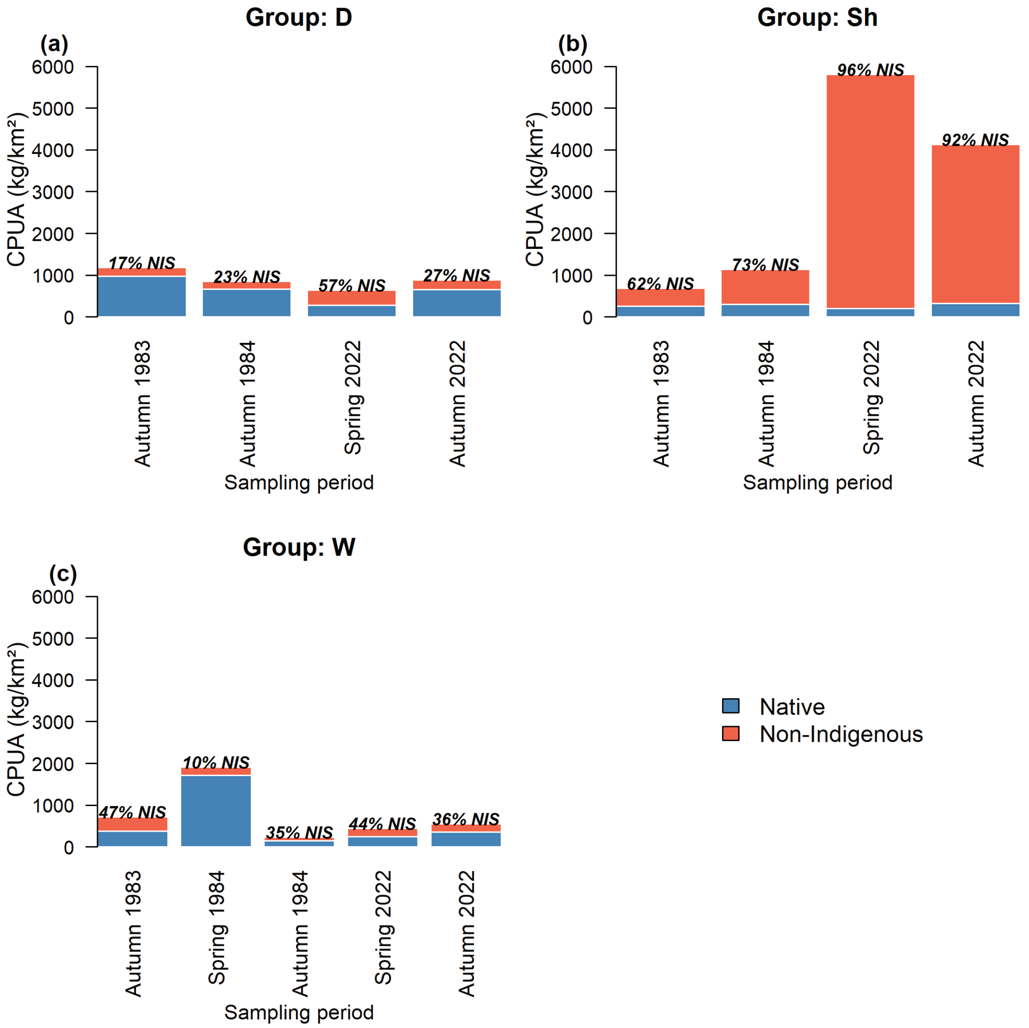

Fig. 3: Total CPUA (kg/km²) of the main groups identified in the cluster analysis, partitioned into native and NIS based on their proportional contributions (%). Panels show the following: (a) Deep water group, (b) Shallow water group (Sh), and (c) Western group (W). Bar height indicates total CPUA, while segments represent the relative contributions of native species and NIS within each group and period.

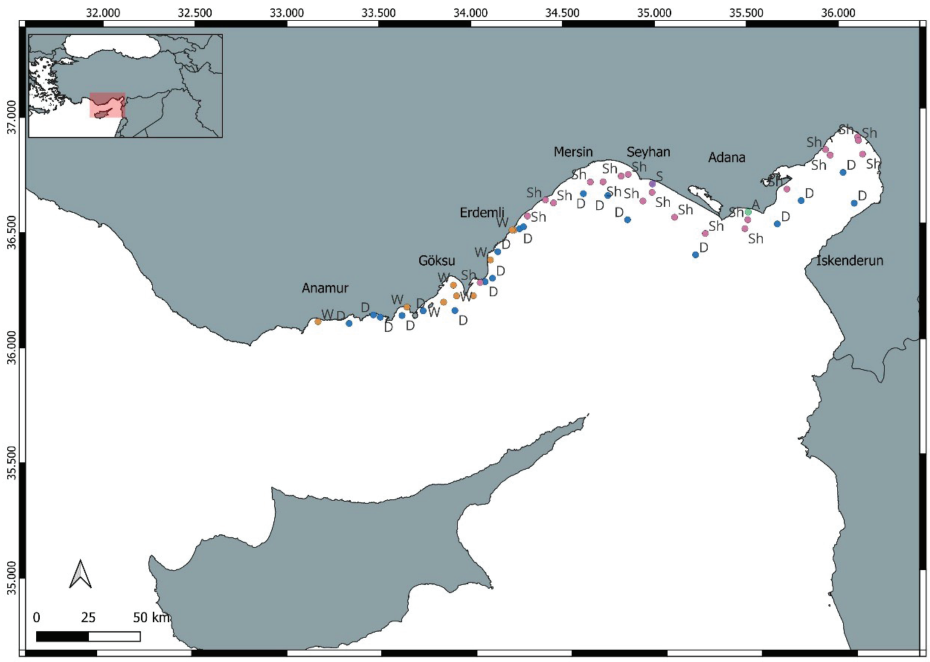

Fig. 4: Spatial distribution of species assemblages in the autumn 1983. Abbreviations: Sh = Shallow, D = Deep, A = Akyayan Lake, S = Seyhan River, W = West of Mersin Bay.

identified. This group was characterized by a particularly high biomass of NIS, exceeding that of other groups sampled in the same period (Table A3). The NIS *E. klunzingeri*, *S. lessepsianus,* and native *Mullus barbatus* accounted for 72% of the total CPUA, making them the dominant species in the trawl catches (Table A4).

According to the ISA, species identified inautumn 1983 had a widespread distribution among the observed groups. For instance, *S. lessepsianus* was an indicator of Deep, Shallow and Western groups (stat = 0.978945, P = 0.004) (Table A16).

Deep (25-75m)

The stations in this group covered deep waters from Iskenderun Bay to the Cape Anamur, excluding a single station in Anamur at 25 meters. A total of 44 teleost fish species, including nine NIS, were identified. The most notable feature of this assemblage was the strong dominance of native species, forming 83% of the total CPUA (Table A3). The top three species with the highest biomass were school-forming benthopelagic native *Boops boops*, *M. barbatus* and the NIS *S. lessepsianus* (Table A2). Additionally, the CPUA of *M. barbatus* surpassed any other group during this sampling period. Native species *Citharus linguatula* (stat=0.95, P=0.001), and *Lepidotrigla cavillone* (stat = 0.89, P = 0.001) served as strong indicators of the combination of Deep and West of Mersin Bay assemblages (Table A16). Based on the SIMPER results, the average dissimilarity between the Deep and Shallow pair was 54%, with *C. linguatula, L. cavillone*, and *Uranoscopus scaber* being the main contributors to this dissimilarity (Table A7). Among the species contributing significantly to this dissimilarity, native species were dominant in both groups but were considerably more abundant in the Deep group (Fig. A4).

West of Mersin Bay (13.5-36m)

This group is located in the western part of Mersin Bay, stretching from Limonlu towards the narrow continental shelf found west of the Göksu River. A total of 41 teleost fish species were identified in this group, 32 of which were native. The most common species was the NIS *S. lessepsianus*, accounting for 33% of the total biomass (Table A4). Native *Pagrus pagrus* (stat=0.81, P=0.005), and *B. podas* (stat=0.71, P=0.005) were relatively strong indicators of this group. The average dissimilarity was 55% between the Shallow and West of Mersin Bay pair, and 50% between the Deep and West of Mersin Bay pair. In both comparisons, the species contributing significantly to the dissimilarity were primarily native and more abundant in the Shallow and Deep groups, respectively (Fig. A4). According to the SIMPER results, *P. pagrus* had the highest contribution to the average dissimilarity between this group and the others (Table A7).

Spring 1984

In spring 1984, 70 teleost fish species were recorded, including 13 NIS. Compared to autumn 1983, native species contribution increased to 75% of the total biomass (Fig. 1). During this season, five clusters were formed at 54% dissimilarity. Three isolated clusters with no common feature with the rest of the fauna are coded as Ec (Eastern coast), Mc (Mersin coast) and A (Akyayan Lake) (Fig. 2 and Fig. A1). The remaining branch was formed by two clusters: W (West of Mersin Bay) and Cd (Coastal to Deep). The most striking change is the mixing of shallow and deep-water groups, resulting in a more uniform view compared to the preceding period (Fig. 2 and Fig. 5).

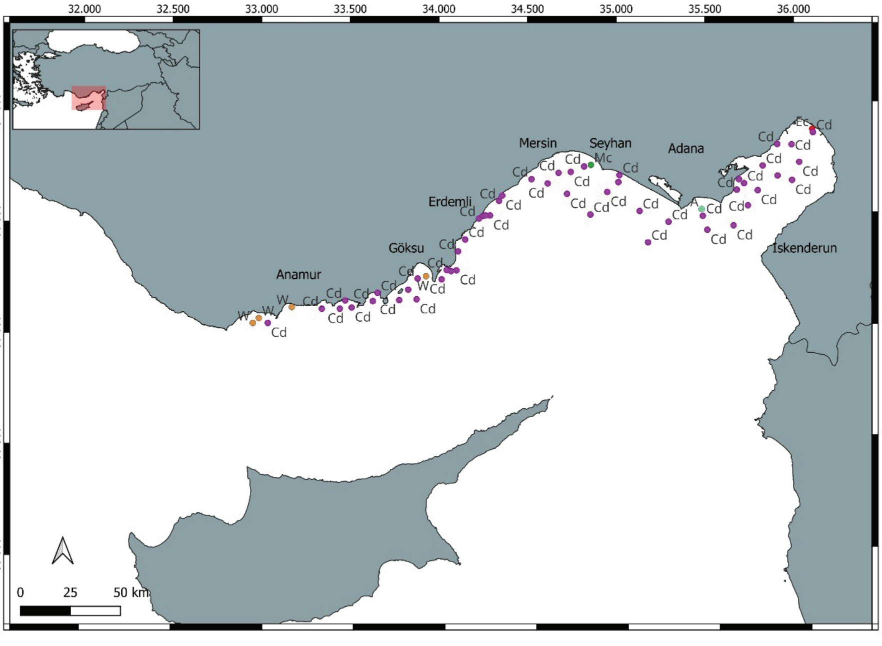

Fig. 5: Spatial distribution of the species assemblages in the spring 1984. Abbreviations: Ec = Eastern coast, Mc = Mersin coast, A = Akyayan Lake, W = West of Mersin Bay, and Cd = Coastal to Deep).

Coastal-Deep (7-77.5)

This group covered a large area, including stations from deep to shallow waters from Iskenderun Bay to Cape Anamur (Fig. 5). Among 63 teleost fish species recorded, 53 native species formed 71% of the total catch. In the CPUA-rank species list, *S. lessepsianus* and *M. barbatus* were the most common species (Table A8). According to SIMPER analysis, the average between group dissimilarity between Coastal-Deep and West of Mersin Bay pair was 65%, with *P. pagrus, Diplodus vulgaris,* and *Mullus surmuletus* being the main constituents of this dissimilarity (Table A9).

West of Mersin Bay (13.5-56m)

The coverage of this group decreased in spring 1984. The main constituent in the former period, *S. lessepsianus,* disappeared from the top 15 species of the highest biomass. The contribution of native biomass remarkably increased to 90%, with *M. barbatus* and *P. pagrus* being the most common species (Table A8). Regarding the ISA results, *M. surmuletus* (stat = 0.99, P = 0.002)*, P. pagrus* (stat = 0.96, P = 0.02)*, and Scorpaena notata (stat = 0.96, P = 0.03)* were strong indicators of this assemblage (Table A17).

Autumn 1984

In autumn 1984, 73 teleost fish species were identified. Although the number of NIS recorded remained the same, their proportion in the biomass increased more than two-fold (Fig. 1, Table A2). During this period, the cutoff level for five clusters indicated a higher differentiation than in previous periods (Fig. 2). In the dendrogram, two main branches can be observed: separating coastal groups in the west from the rest of the region. The observed groups were coded as W (West of Mersin Bay) and Wc (West coast), Shallow (Sh), Deep (D), and I (Intermediate) (Fig. 5). According to the SIMPER analysis, the average dissimilarity was highest between the Intermediate and Western groups (87%) and lowest between the Intermediate and Deep groups (61.8%) (Fig. A3).

Shallow (7-46m)

This group extends from Iskenderun Bay to the area west of the Göksu River, reaching as far as Cape Anamur. In Iskenderun Bay, it covers depths of 7 and 46 meters, while in Anamur, it spans depths of 25 to 34 meters. A total of 63 teleost fish species were identified in this group. Notably, the contribution of NIS increased to 73% of the total biomass (Table A3). The top three species by biomass were exactly the same as in autumn 1983 (Table A8). However, the proportion of *E. klunzingeri* increased, while that of *M. barbatus* declined. This shift notably impacted the dissimilarity between the groups. Indicator species analysis showed that *E. klunzingeri* (stat = 0.94, P = 0.001) was widespread across all coastal groups up to the the mouth of Göksu River (Sh, I, Wc) (Table A18). The average dissimilarity was 63% between the Shallow and Intermediate groups, and 75% between the Shallow and West of Mersin Bay groups. Notably, *E. klunzingeri* became the main contributor to the average dissimilarity between the Deep and Shallow groups in this period. Among the species contributing significantly to the dissimilarity between the Shallow and West groups, NIS were dominant for the first time (Fig. A4). The second most important species contributing to this dissimilarity was *L. cavillone*, maintaining the same average contribution as in autumn 1983 (Table A11).

Intermediate (38-44m)

The subregion (I) exhibits a patchy distribution at intermediate depths across both the eastern and western parts of the study area. It replaced part of group Cd around Yumurtalık Lagoon and the small bay west of the Göksu River, previously observed in spring 1984 (Fig. 6). The NIS *S. lessepsianus* is the primary constituent of this group, contributing 65% of the total catch. The overall average dissimilarity between the Intermediate and Shallow groups is 63%, with *E. klunzingeri, M. barbatus*, *and Sphyraena chrysotaenia* being the top three contributors (Table A11). Based on the ISA, *S. chrysotaenia* is also a strong indicator of this group (stat= 0.94, P=0.001) (Table A18).

Deep (55m-82m)

Similar to the previous periods, this subregion extends from Iskenderun Bay to the Cape Anamur. However, its lower depth boundary is now located in deeper waters compared to the spring 1983 (Fig. 6). The proportion of native biomass has dropped to 77%. As in the autumn of 1983, *M. barbatus* remains the most trawled fish, but the rest of the CPUA ranked species list was notably changed (Table A10). The average dissimilarity between Deep and West of Mersin Bay is 65%, with *C. linguatula* and *Dentex macrophthalmus* being the most important contributors to this dissimilarity (Table A11).

West of Mersin Bay (33-66m)

In contrast to earlier periods, this group was confined to the western end of the study area and covered deeper waters. Compared to spring 1984, the contribution of NIS biomass increased to 35% (Table A3). Formerly a common species, *M. barbatus* disappeared from the CPUA-ranked species list (Table A10). *D. macropthalmus* was not only the most common species in terms of biomass but also a strong indicator of western groups (stat = 0.94, P = 0.003) (Table A18). Based on the SIMPER results, *E. klunzingeri* and *D. macrophtalmus* were the top

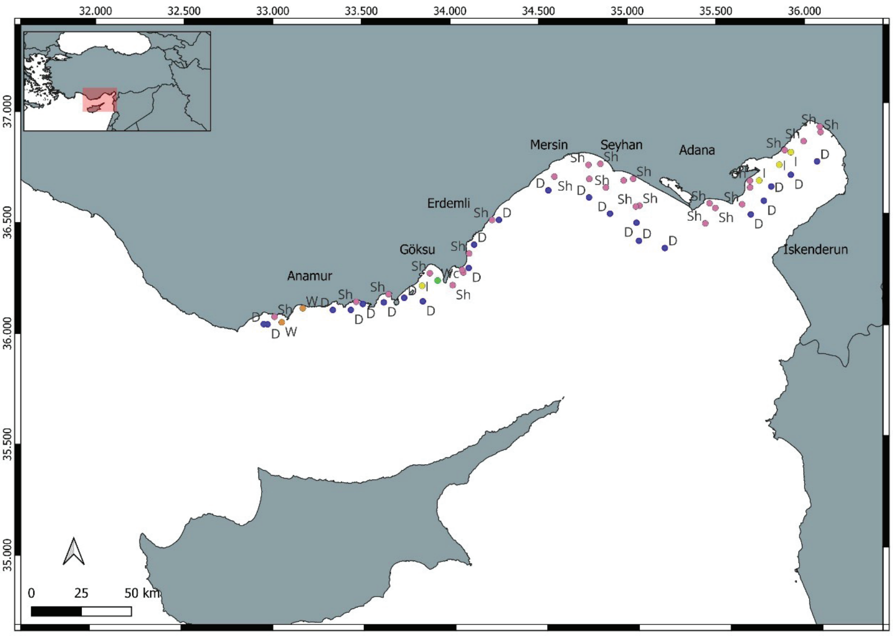

Fig. 6: Spatial distribution of the species assemblages in the autumn o1984. Abbreviations: Sh = Shallow, W = West of Mersin Bay, Wc = West coast, I = Intermediate, and D = Deep.

two species contributing to the differentiation between this group and the Shallow group (Table A11).

Spring 2022

In spring 2022, 108 teleost fish species, including 33 NIS, were caught. The contribution of NIS was the highest among all sampling periods, comprising 92% of the total biomass (Fig. 1). The average dissimilarity among all main groups increased. Generally, two distinct branches can be recognized, separating the West of Mersin Bay (W) and from rest of the groups. In addition to Sh (Shallow) and D (Deep) groups, two more coastal groups were observed and coded as Ec (Eastern coast), L (Limonlu) (Fig. 7).

Shallow (6-38m)

In spring 2022, this group extended from Iskenderun Bay to the west of the Göksu River. Its western and eastern extent was shorter compared to the autumn 1984 (Fig. 7). Across all sampling periods, the highest biomass of NIS was recorded in this group, with native fish accounting for only 3% of the total CPUA. The penetration of new NIS dramatically altered the species composition. The contributions of *S. lessepsianus* and *E. klunzingeri* were reduced to very low levels, whilst the striped piggy, *P. stridens,* accounted for 91% of the total catch (Table A12). Based on ISA, *Sparus aurata* (stat = 0.91, P = 0.001) was a strong indicator of this group, whereas *P. stridens* (stat = 0.90, P = 0.001) was an indicator of this group and the other coastal group off the coast of Limonlu (Table A19). According to the SIMPER results, *P. stridens* also had the highest contribution to average dissimilarity between Shallow, Deep and West of Mersin Bay groups (Table A12).

Deep (34-74m)

During this season, this group was confined to the western part of Iskenderun Bay, extending from intermediate to deeper waters near Akyayan Lake, reaching Cape Anamur. For the first time across the sampling periods, this specific group was predominantly inhabited by non-native fish species, accounting for 57% of the total biomass (Table A4). Notably, although the percentage contribution of *M. barbatus* increased compared toautumn 1984, *P. stridens* constituted the majority of the biomass in this group (Table A13). According to the SIMPER results, the average dissimilarity between the Deep group and the West of Mersin Bay group was 75% with *Upeneus pori* and *Parupeneus forsskali* contributing most significantly to the dissimilarity between them (Table A13).

West of Mersin Bay (10.5-39.2m)

The stations labelled under this group were confined to small bays along the western part of the Göksu River (Fig. 7). Although it was the only subregion with native fish dominance in spring 2022, the contribution of NIS remained higher than in the preceding periods. The formerly common *Stephanolepsis diaspros* was no longer among the top 15 species with the highest biomass, and *Diplodus vulgaris* and *Epinephelus aeneus* became the top two important species in biomass (Table A3). Furthermore, *P. forsskali* (stat = 0.88, P = 0.002) was a strong indicator of this group (Table A19). Based on SIMPER results, *P. stridens*, *P. forsskali*, and *S. aurata* contributed the most to the differences between West of Mersin Bay and Shallow groups (Table A13).

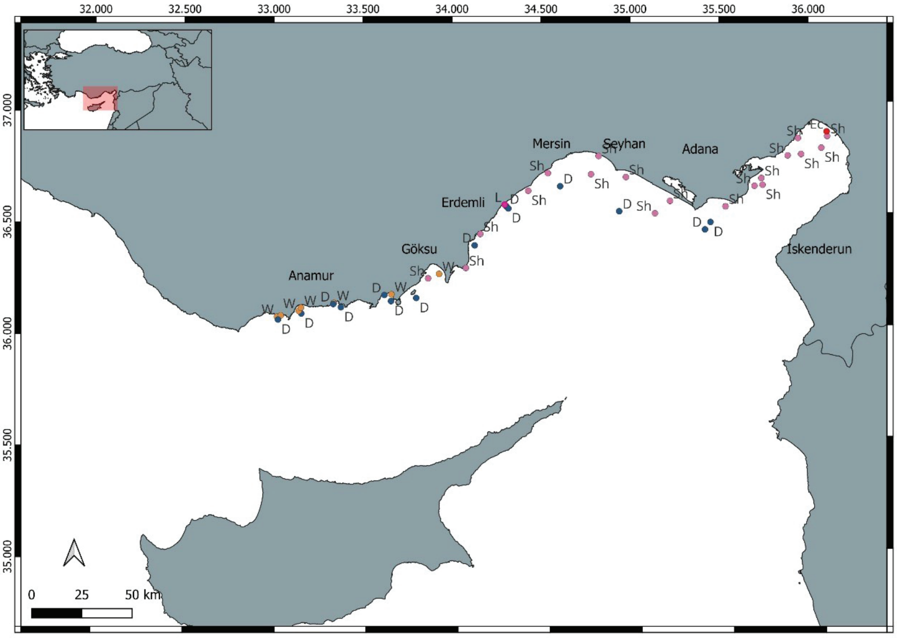

Fig. 7: Spatial distribution of the species assemblages in the spring 2022. Abbreviations: Sh = Shallow, W = West of Mersin Bay, Ec = Eastern coast, L = Limonlu, and D = Deep).

Autumn 2022

In autumn 2022, 107 teleost fish species were recorded. Among them, 35 NIS accounted for 83% of the total biomass (Fig. 1, Table A2). The cut-off level for five clusters was 57%. A completely isolated group with no common feature with the others was coded as "X". The remaining stations were divided into two main branches one consisting solely of the Deep (D) group, and the other comprising the West of Mersin Bay (W), Coastal-Intermediate–Shallow (CI-Sh), and Deep in the East (Ed) clusters (Fig. 2 and Fig. 8).

Shallow (11.5-41.5m)

Stations categorized under this group encompassed waters between the 11.5 m to 41.5 m isobaths, extending from the easternmost part of Iskenderun Bay to the west of the Göksu River mouth, with an additional patch of this group present at the western end of the study area (Fig. 8). The proportion of NIS biomass slightly decreased compared to the spring 2022 but remained notably higher than in the 1980s. As in the former period, *P. stridens* dominated the biomass, contributing 70% of the total catch, followed by *E. klunzingeri* (Table A14). *Argyrosomus regius* (stat = 0.83, P = 0.009) was a strong indicator of this assemblage (Table A20). The average dissimilarity between the Shallow and West of Mersin Bay groups decreased to 65%, with *A. regius* and *P. forsskali* being the top two contributors. The average dissimilarity between the Shallow and Deep groups also decreased to 67% with *P. stridens* and *E. klunzingeri* being the top two contributors to this dissimilarity (Table A15).

Deep (59.5-70.5m)

This group once again covered a large extent, similar to autumn 1984, including stations deeper than 59.5m. It was dominated by native biomass, as in the 1980s, but with a lower percentage contribution. The CPUA of *P. stridens* decreased remarkably, whereas *M. barbatus* increased (Table A15). In addition, *Champsodon nudivittis* and *Pagellus acarne* significantly contributed to the intergroup dissimilarity between the Deeper group and Shallow groups (Table A16).

West of Mersin Bay (15-47.5m)

The western extent of this group was replaced by the Shallow group comparedto spring 2022 (Fig. 8). The proportion of NIS decreased to 36% (Table A1). *D. vulgaris*, the most common species in spring 2022, disappeared from the top 15 species by biomass (Table A14). Conversely, *M. barbatus*, which had disappeared after spring 1984, became very abundant in this season. The NIS *P. forsskali* (stat = 0.92, P = 0.008), and native *B. podas* (stat = 0.80, P = 0.07) were strong indicators of this group (Table A20). However, *B. podas* and *P. forsskali* ranked low on the CPUA list. The average dissimilarity between Deep and West of Mersin Bay groups was 67% with *C. nudivittis* and *P. forsskali* making the highest contributions (Table A15). Interestingly, *P. forsskali* occured exclusively in Western group, whereas *C. nudivittis* (ava=0, avb=3.459) occurred exclusively in the Deep group (ava =3.221, avb=0). Among the species contributing significantly to the dissimilarity, native species were dominant in the Deep group (Fig. A4).

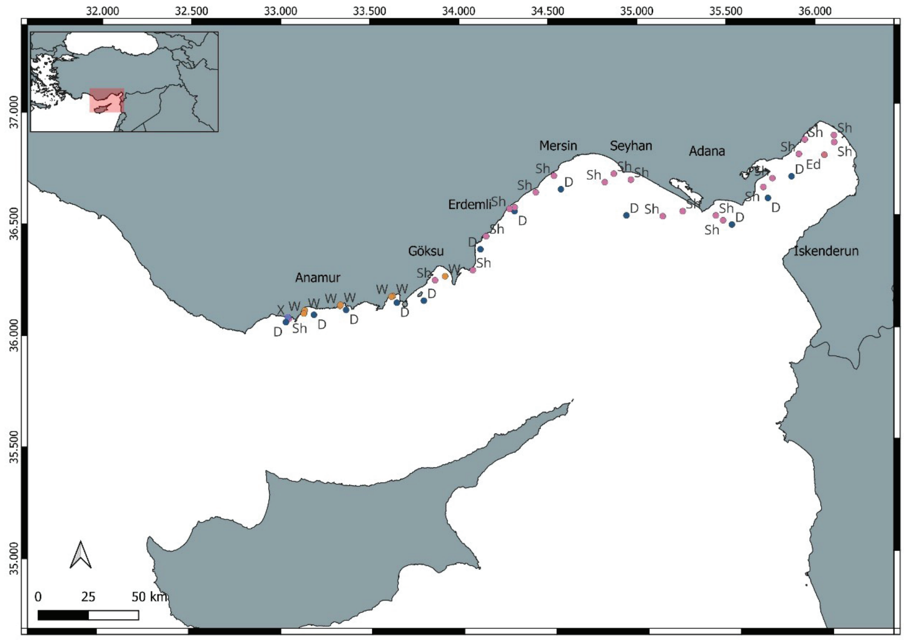

Fig. 8: Spatial distribution of the species assemblages in the autumn 2022. Abbreviations: Sh= Shallow, D = Deep, W = West of Mersin Bay, Ed = Deep in the east, and X = No common feature).

Discussion

Globally, the introduction of NIS is recognized as one of the primary drivers of biodiversity change (Galil, 2023). A well-documented case of this phenomenon is the continuous influx of tropical NIS into the Mediterranean Sea, facilitated by the construction of the Suez Canal (Galil, 2007). Given that the introduction and spread of NIS is an ongoing process, understanding the direction and scale of these changes is crucial for mitigating future impacts on the Mediterranean ecosystem. In this study, we combined demersal trawl survey data from the 1980s with newly collected data from 2022 to examine and characterize changes in the composition of demersal fish assemblages over time. Despite substantial spatio-temporal variability in species composition, one of the key findings of this study is the identification of three major assemblages with distinct characteristics in the Northeastern Mediterranean Basin: The Shallow Group (Sh), the Deeper Group (D), and the Western Group (W). This classification formed the basis for further analyses of regional biomass patterns and NIS dynamics.

Our analysis revealed a remarkable increase in the contribution of NIS biomassover the course of the study period. Total CPUA increased significantly, rising from approximately 750-970 kg/km² in the 1980s to over 2,400 kg/km² by 2022. This overall increase in biomass was primarily driven by NIS and was not uniform across groups. In the autumn 1983, NIS constituted 25% of the total biomass. By 2022, their contributions had surged to 92% in the spring and 83% in the autumn. The Shallow group experienced the most substantial increase in CPUA, largely driven by a sharp rise in NIS biomass, whereas native species biomass remained relatively stable. In contrast, in the Deep group group, native CPUA declined while NIS biomass increased slightly. Consequently, the NIS share of total CPUA increased in the Deep group over time. The Western group exhibited a fluctuating pattern in total CPUA, peaking at 1,907.6 kg/km² in the early 1980s, followed by a sharp decline and partial recovery by 2022 (549.2 kg/km²). Changes in NIS contributions to CPUA within this group were more complex and require consideration of shifting spatial coverage during the sampling periods. In 1983, when NIS contributions reached 47%, the Western group extended eastward, covering more central parts of the study area where NIS presence was higher. In subsequent years, the spatial extent of the Western group was limited to the westernmost part of the study area. Within this narrower area, NIS contributions varied significantly depending on whether stations from the Göksu region were included in the Western group, based on clustering results. Their contribution was lower when the group extended to the Göksu region, probably due to freshwater input from the river. These spatial shifts likely influenced the observed variation in NIS dominance within the Western group over time. Overall, excluding 1983, when the Western group extended eastward, NIS contributions in this group showed an increasing trend, rising from 10–35% in 1984 to 36–44% in 2022, indicating a gradual rise in NIS dominance.

Although the methodological differences complicate direct comparisons, our findings suggest a substantially higher contribution of NIS than previously estimated (Gücü & Bingel, 1994; Mavruk *et al.*, 2017), confirming the unprecedented pace of NIS spread in the region. This pattern reflects the growing dominance of NIS in shallow and deep-water habitats as well as a westward extension of their distribution within the Northeastern Mediterranean region. This regional progression is consistent with the broader expansion of NIS described in previous studies (e.g., Lasram et *al.*, 2008) and may be interpreted as a ongoing extension of the so-called ‘Lessepsian Province’ along the Northeastern Mediterranean coast (Galil, 1993).

The Shallow group consists of waters primarily within the infralittoral zone, extending from İskenderun Bay to the vicinity of Göksu River mouth, with an additional patch near the western boundary of the study area. This zone has been the most impacted by the spread of NIS and was already dominated by NIS biomass in the 1980s, with contributions ranging from 62% to 73%. According to Gücü & Bingel (1994), this area corresponds to Por's "Lessepsian Province", which is characterized by shallow depths and soft-bottom habitats (Avşar, 1999; Por, 2010). One possible explanation for the success of NIS in this zone is the "boom-bust" dynamic (Pianka, 1970). A typical example is *E. klunzingeri*, which exhibits a high reproduction rate (r-selected; Pianka, 1970), and ischaracterized by phases of rapid population growth followed by sharp declines (Gücü & Bingel, 1994). During the 1980s, NIS biomass in the Shallow-water group was primarily composed of *S. lessepsianus* and *E. klunzingeri*, which alternated in dominance. Since their introduction to the Eastern Mediterranean in the 1950s, both species have established viable populations (Erazi, 1943; Ben-Yami & Glaser, 1974; Gücü & Bingel, 1994; Özyurt *et al*., 2018). *S. lessepsianus*, due to its high commercial value, was more affected by fisheries, whereas the non-commercial *E. klunzingeri* experienced less pressure, potentially explaining the alternating dominance between the two species (Mutlu *et al*., 2023). By 2022, NIS biomass in this group reached up to 97%, with *P. stridens* emerging as the dominant species. This newcomer accounted for up to 90% of the total biomass, significantly altering the species composition within a short period. The first occurrence of this species in the study area was reported in 2009 in Iskenderun Bay (Bilecenoğlu*et al*., 2009). Its population rapidly increased and spread westward along the coastal habitats, becoming one of the most dominant species after 2013 (Ergüden *et al*., 2010; Mavruk *et al*., 2017; Eşkinat *et al*., 2023). Our findings indicated that the biomass of *P. stridens* has continued to increase significantly, suggesting that its rapid expansion in coastal habitats is still ongoing. Mavruk *et al*. (2017) linked the success of *P. stridens* to rising annual minimum temperature in İskenderun Bay. However, a single factor alone cannot fully explain the invasion process (Belmaker *et al*., 2013). Recent studies have explored various aspects of the impacts and success of *P. stridens* (Özbek, 2017; Uyan *et al*., 2018; Eşkinat *et al*., 2023; Tüzün & Gücü, 2023, 2024), suggesting the potential long-term persistence of this species in the basin.

The Western group generally extends from the shallow infralittoral zone to the lower circalittoral zone, covering the area where the continental shelf narrows significantly in the west. Although the Shallow group occasionally extends into the western region, the area near the Göksu River mouth and east of the Cape Anamur consistently remains within this group. This region exhibits diverse bottom structures, including sandy substrates, rocky formations, and *Posidonia oceanica* meadows (Mutlu, 2015; Eşkinat, 2024). Notably, the range of *P. oceanica* is confined to this area and does not extend eastward beyond Beşparmak Island (Gücü & Gücü, 2002). *P. oceanica* is endemic to the Mediterranean Sea and provides critical habitat for settlement, nurseries, shelter, and food for various marine species (Kalogirou *et al*., 2012b; de Meo *et al*., 2018). Typical species in the Western group include those adapted to rocky bottoms with vegetation, sandy and muddy substrates, and seagrass meadows, such as *B. podas*, *D. vulgaris*, *S. diaspros*, *P. forsskali*, *D. dentex*, and *S. rivulatus*. According to Kalogirou *et al*. (2012b), *P. oceanica* meadows may be more resitant to the spread of NIS, as their abundance is lower in seagrass habitats compared tosandy bottoms.

Consistent with this observation, the Western group remained the only group dominated by native biomass throughout the study period. However, this group exhibited the greatest increase in the proportion of NIS relative to the total recorded species, nearly doubling since the 1980s. This indicates a substantial shift in species composition. In line with this, SIMPER results showed that, among the species contributing to the dissimilarity between this group and others, NIS biomass increased significantly from the 1980s to the 2020s, ultimately becoming dominant in recent years. While native species, such as *B. podas* and *D. dentex,* contributed to this group's uniqueness in the 1980s, by 2022, NIS had become a key distinguishing feature. Interestingly, some NIS, such as *Pteragogus trispilus*, were found exclusively in this group. In contrast, others, such as *P. forsskali*, were far more abundant here than in any other part of the study area. In addition to seagrass meadows, one possible explanation for this trend is the implementation of a Fishery Restricted Area (FRA) in 1999, which banned all industrial-scale fishing (Gücü & Erkan, 2001). Although these zones are intended to function as protected areas (Gücü & Erkan, 2001), our results suggest that the dynamics of NIS spread are more complex. The absence of fishing pressure in protected areas may have inadvertently allowed NIS populations to thrive. Similarly, studies by D'Amen & Azzurro (2020) and Eşkinat (2024) also highlight the vulnerability of Marine Protected Areas (MPAs) to NIS invasions in the Northeastern Mediterranean. In light of the growing risks associated with NIS in this region, it is essential to understand how species assemblages are shifting at the local scale, as various drivers interact across spatial gradients.

Another notable feature of the study area is a distinct group in deeper waters, located in the circalittoral zone and extending widely from east to west, except in spring 2022. This community remains relatively stable and characterized by high proportion of native biomass, though the contribution of native biomass and the ratio of native species to the total number of species were considerably lower than in the 1980s. The species assemblage in this group includes commercially important native species, such as *M. barbatus*, *M. merluccius*, and *P. erythrinus*, alongside non-commercial native species like *C. linguatula* and *S. hepatus*, as well as NIS *C. nudivittis*. Among these, *M. barbatus* emerged as a key component of this group, dominating nearly all sampling periods except for spring 2022, when *P. stridens* drastically altered the species composition. Notably, NIS biomass increased substantially in both spring 1984 and 2022. The minimum bottom depth occupied by this group varies across the study period and regions but consistently remains deeper than other groups. According to Gücü (2021), the timing and deepening of the thermocline layer during spring drive the movement of native fauna towards deeper waters in the Eastern Mediterranean. However, the lack of continuous year-round monitoring prevents confirmation of a direct relationship between thermocline dynamics and depth variations. In addition to interannual differences in the duration and deepening of the seasonal thermocline, the intrusion of colder and fresher modified Atlantic water into the study area is known to affect the spatial distribution of species, particularly the occurrence of *M. merluccius* (Gücü & Bingel, 2011).

Beyond hydrographic complexity, shifts in community structure within the Deep-water group have also been associated with inshore-offshore spawning migrations (Gücü & Bingel, 1994, 2022). Consistent with this pattern, our results showed a higher biomass of *M. barbatus* in autumn compared to spring. Notably, despite seasonal fluctuations in species composition, the total CPUA of this group has steadily decreased since autumn 1983. PERMANOVA, PERMDISP, and PERMUTEST analyses indicated that depth strata and sampling region significantly influence the structuring of teleost fish communities in trawling grounds, confirming clear distinctions between eastern and western regions as well as between shallow and deeper waters. Moreover, our findings suggest that the spread of NIS has extended into deeper and western waters compared to earlier periods. These species, which have different habitat preferences, are establishing stable biomass levels and alternating the faunal composition of the Northeastern Mediterranean. For instance, while *P. stridens* proliferates in coastal waters, *C. nudivittis* occupies deeper groups, and *P. forsskali* predominantly settles near seagrass meadows.

Early scientific understanding suggested that thermal barriers would limit the spread of NIS in the Mediterranean (Por, 1978). However, subsequent studies revealed that some NIS possess a broader climatic niche than previously assumed (Arndt & Schembri, 2015). A total of 15 NIS have already expanded beyond the Strait of Sicily, which is recognized as a biogeographic barrier (Azurro *et al*., 2022b). The ongoing influx through the Suez Canal, enhanced by its subsequent enlargements, is expected to continue driving the increase in NIS numbers in the Mediterranean (Galil, 2023). Considering the deepening and westward movement of non-indigenous fish, along with the Mediterranean's vulnerability to climate change and projections of increasing marine heatwave events (Hamdeno & Alvera-Azcaráte, 2023), demersal fish communities in the western Mediterranean could soon face challenges from NIS similar to those currently encountered by the Eastern Mediterranean. Given the limited success of traditional measures, such as Marine Protected Areas (MPAs), in managing diversity in areas under NIS pressure (Eşkinat, 2024), we emphasize the urgent need to develop new strategies to guide the direction of the change.

Conclusion

The impacts of NIS introductions are particularly pronounced in the Northeastern Mediterranean Sea, predominantly driven by the opening of the Suez Canal, which enabled the influx of NIS into the basin. Climate change, anthropogenic threats, and vacant niches have further accelerated this transformation by creating favourable conditions for tropical biota, leading to drastic changes in demersal fish composition.

By analyzing historical and recent data, this study comprehensively assesses changes in demersal fish assemblages over time. Our results revealed significant spatial and depth-related patterns in community formation. We observed a remarkable increase in the contribution of NIS biomass since the 1980s, accompanied by distinct shifts in species composition across the basin. Our findings identified three major assemblages: (1) Shallow, (2) Western, and (3) Deeper groups, each characterized by unique species compositions and varying degrees of NIS influence. The Shallow group was dominated by NIS biomass throughout the study period, with *S. lessepsianus* and *E. klunzingeri* as the primary contributors in earlier years. By the 2020s, *P. stridens*, introduced to the region in 2009, proliferated, with its biomass reaching up to 91% of the total CPUA. The Western group, which includes *P. oceanica* meadows and a Marine Protected Area (MPA), remains dominated by native biomass but exhibited the highest rate of increase in NIS numbers. Among these, *P. forsskali* has become an indicator species for this assemblage. In the Deeper group, native species, particularly *M. barbatus*, continue to play a significant role; however, the number of NIS has risen, and their biomass showed notable growth during spring periods, reaching up to 57% in 2022. Additionally, NIS, such as *C. nudivittis*, have begun to emerge as distinguishing elements of this group. These findings confirm that NIS are no longer confined to shallow coastal waters but have progressively expanded into deeper waters and western regions. As the inflow of NIS remains inevitable, we emphasize the urgent need for adaptive management strategies tailored to local ecological contexts to mitigate their long-term impacts in the Mediterranean Sea.

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APPENDIX I

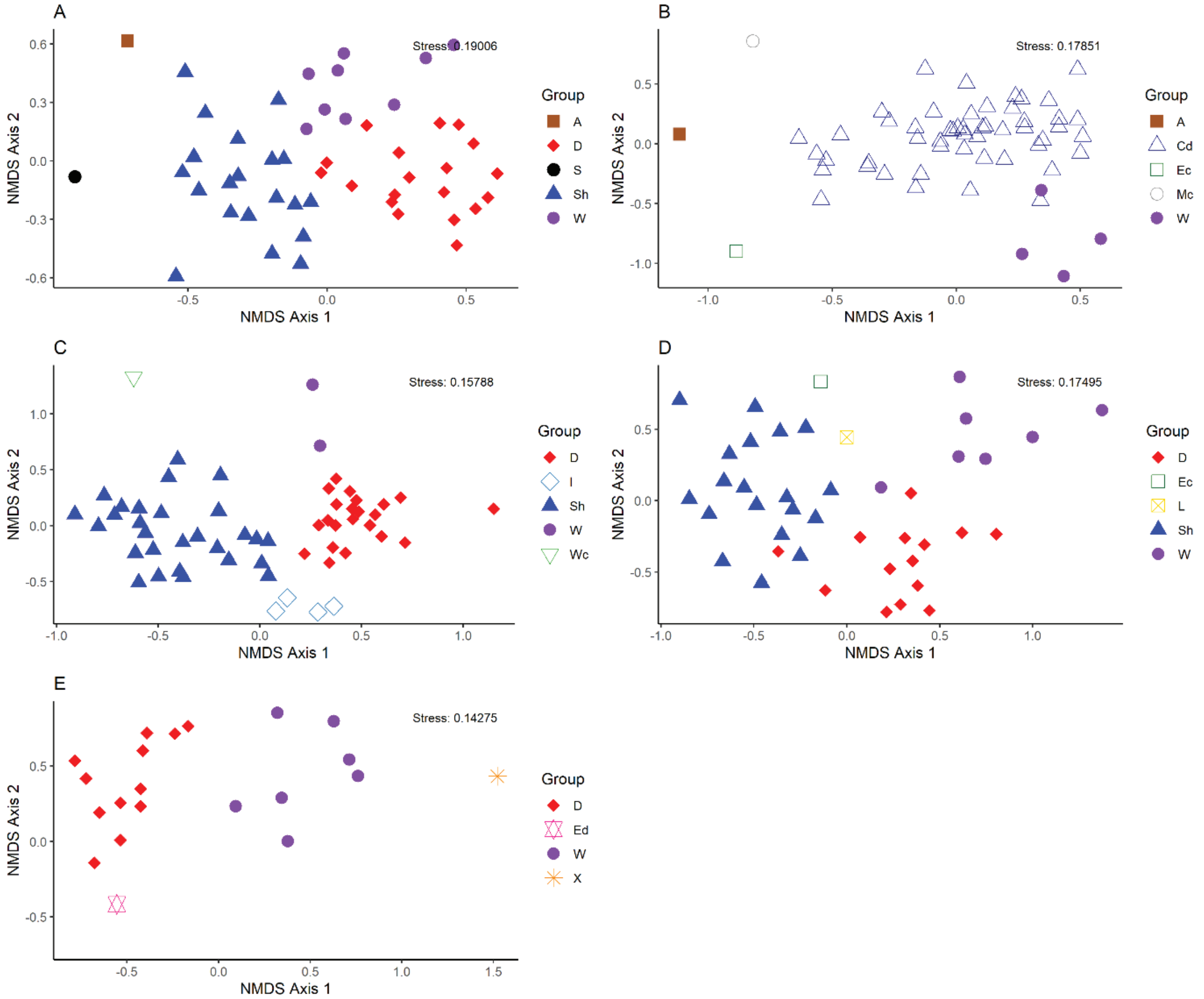

Fig. A1: Two-dimensional NMDS biplots are displaying clusters identified. (A: Autumn 1983, B: Spring 1984, C: Autumn 1984, D: Spring 2022, E: Autumn 2022) (S: Seyhan River, A: Akyayan Lake, Sh: Shallow, D: Deep, W: West of Mersin Bay, Ec: Eastern coast, Mc: Mersin coast, Cd: Coastal-Deep, Wc: Western coastal, L: Lamas, Ed: Deep in the east, and X: No common feature).

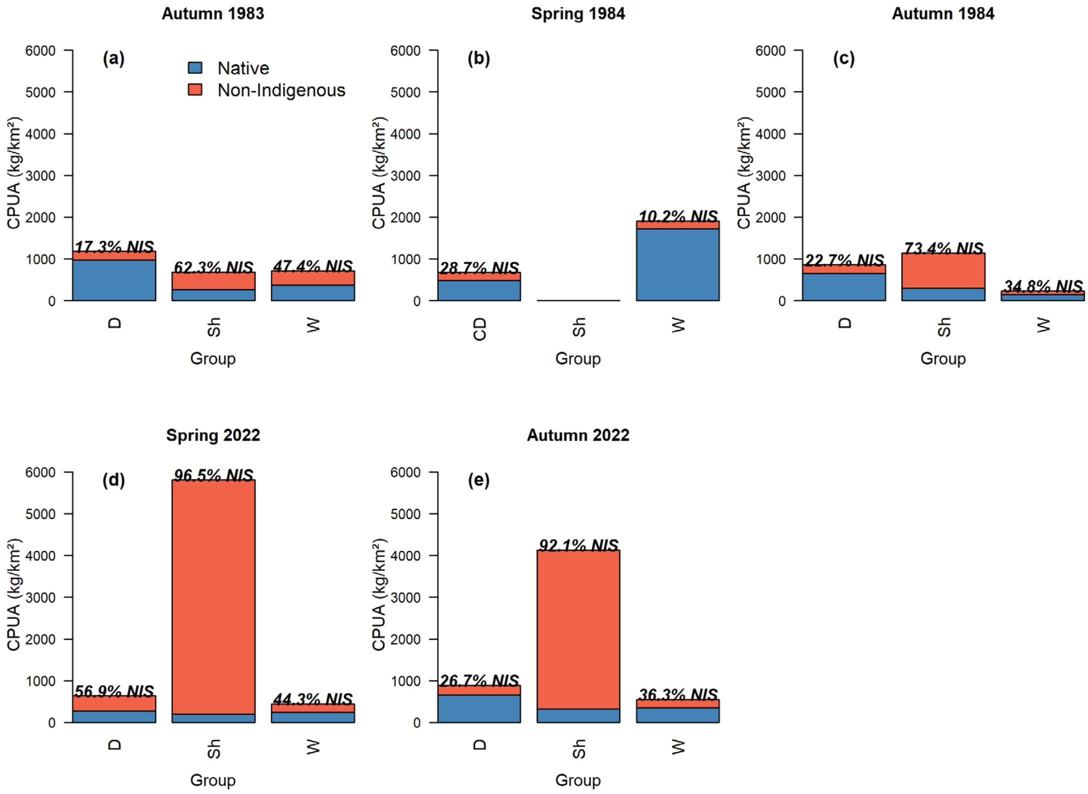

Fig. A2: Total CPUA (kg/km²) of sampling periods per cluster, partitioned into native and non-indigenous species (NIS) based on their proportional contributions (%). Years are indicated above each panel; bar height represents total CPUA, and segments show the relative contributions of native and NIS species within each cluster.

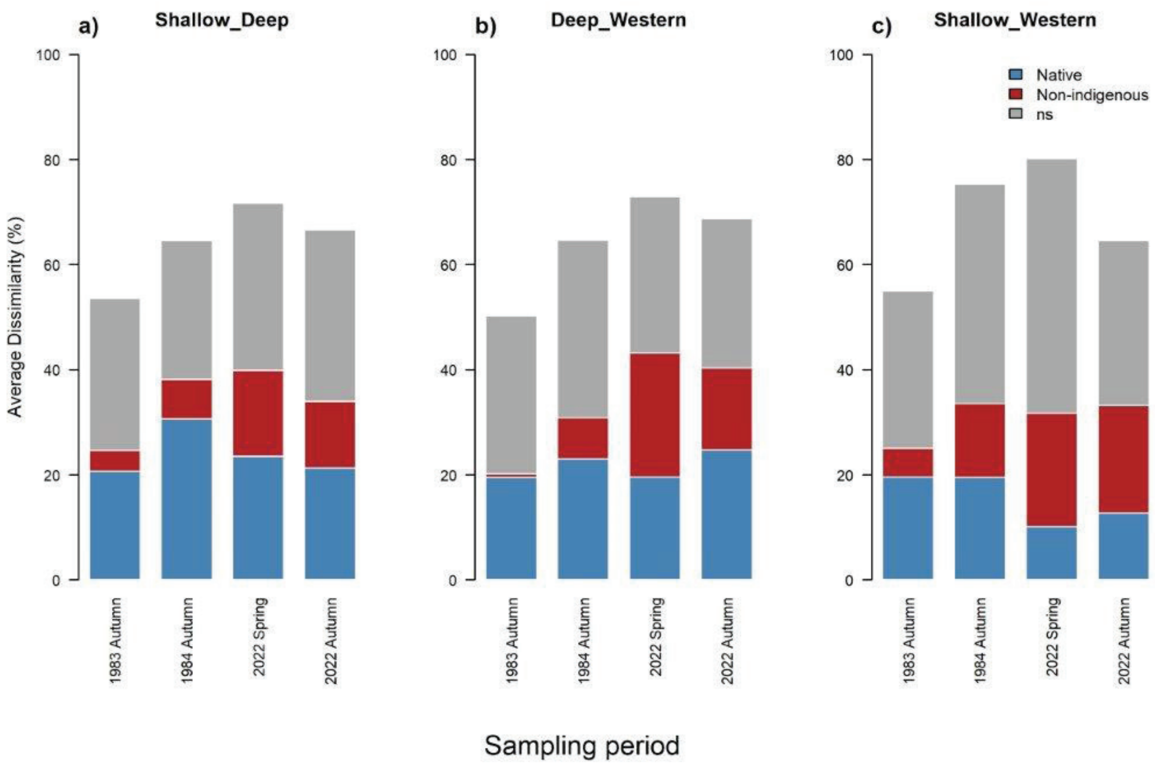

Fig. A3: Average dissimilarity values between groups, as assessed by SIMPER. Bars show the relative contributions of native species, NIS, and non-significant contributors (including both native and NIS species).

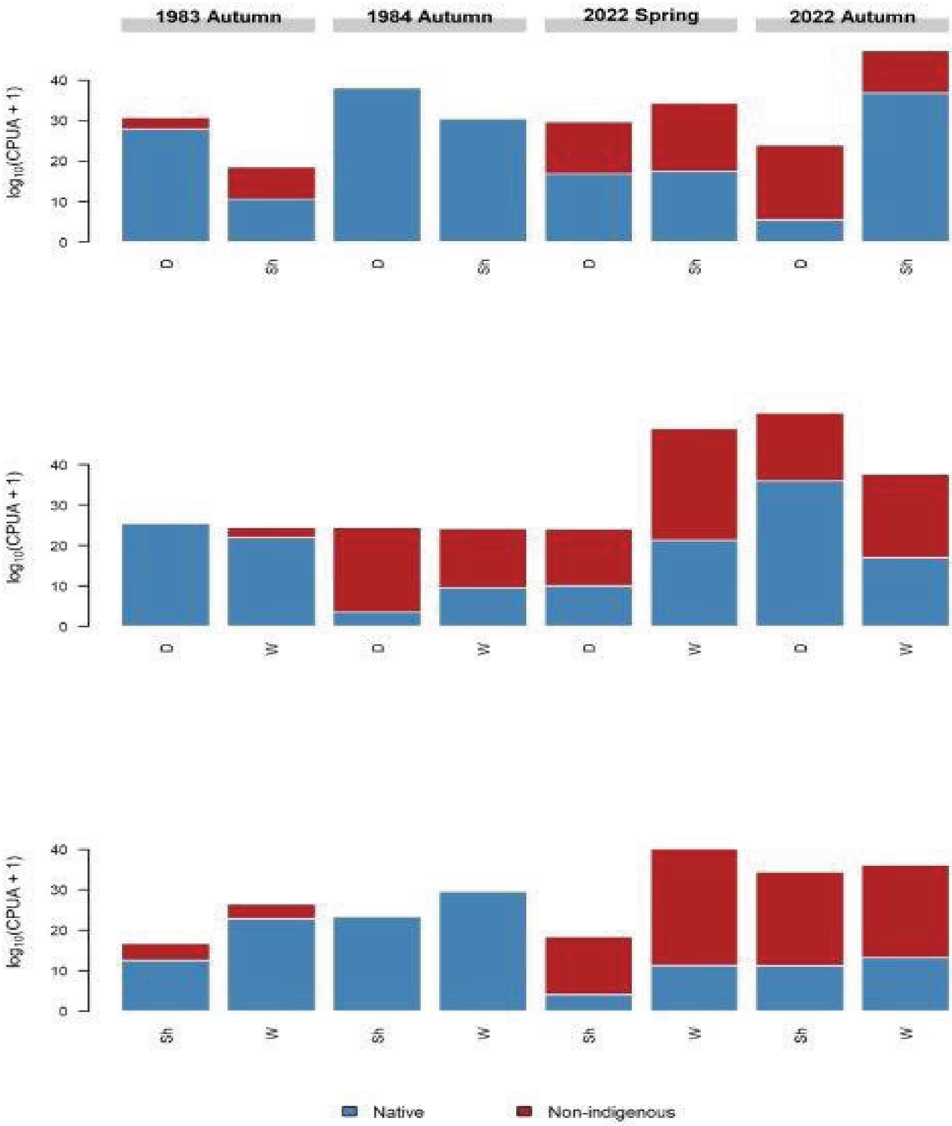

Fig. A4: Log(x+1)-transformed average CPUA of NIS and native species that contributed significantly to dissimilarities between the main groups in the SIMPER analysis. Bars represent average CPUA within each group, aggregated by species origin (NIS vs native).

Table A1. Geographic coordinates, sampling dates, and times for each station.

Date	Latitude	Longitude	Time (start)	Time (end)
26-Sep-83	36.57333° N	34.295° E	11:48	12:08
26-Sep-83	36.64167° N	34.39333° E	13:36	13:56
26-Sep-83	36.62833° N	34.43667° E	14:34	15:04
26-Sep-83	36.66667° N	34.59833° E	17:34	18:15
26-Sep-83	36.71667° N	34.63667° E	18:57	19:27
27-Sep-83	36.74° N	34.80333° E	13:16	13:46
27-Sep-83	36.74667° N	34.84167° E	14:57	15:27
27-Sep-83	36.70333° N	34.97167° E	8:43	9:13
27-Sep-83	36.63° N	34.91833° E	9:50	10:20
27-Sep-83	36.65666° N	34.73° E	11:35	12:05
28-Sep-83	36.71667° N	34.705 E	8:17	8:47
28-Sep-83	36.55° N	34.83333° E	10:57	11:27
28-Sep-83	36.39167° N	35.195° E	15:30	16:00
29-Sep-83	36.57167° N	35.48333° E	8:08	8:38
29-Sep-83	36.53833° N	35.48° E	9:12	9:42
29-Sep-83	36.51667° N	35.63833° E	14:23	14:57
29-Sep-83	36.615° N	35.77° E	16:21	16:51
29-Sep-83	36.66667° N	35.695° E	17:58	18:28
30-Sep-83	36.83333° N	35.91° E	8:25	8:55
30-Sep-83	36.80833° N	35.93333° E	9:50	10:20
30-Sep-83	36.73167° N	36° E	12:01	12:31
30-Sep-83	36.88333° N	36.085° E	14:21	14:51
30-Sep-83	36.86833° N	36.08833° E	15:16	15:46
30-Sep-83	36.80833° N	36.10833° E	16:37	16:47
1-Oct-83	36.59667° N	36.055° E	9:26	10:06
1-Oct-83	36.5° N	35.46333° E	14:11	14:41
2-Oct-83	36.48333° N	35.25° E	9:08	9:38
2-Oct-83	36.55667° N	35.08667° E	11:38	12:08
2-Oct-83	36.66667° N	34.96833° E	13:14	13:44
1-Nov-83	36.51333° N	34.22333° E	10:37	11:07
1-Nov-83	36.51333° N	34.21167° E	11:40	12:10
1-Nov-83	36.51833° N	34.25167° E	12:41	13:11
1-Nov-83	36.52667° N	34.27333° E	14:15	15:00
2-Nov-83	36.42° N	34.13333° E	8:40	9:10
2-Nov-83	36.385° N	34.09333° E	9:37	10:07
2-Nov-83	36.305° N	34.10333° E	11:02	11:32
2-Nov-83	36.29° N	34.06333° E	12:02	12:36
2-Nov-83	36.28667° N	34.03667° E	13:09	13:43
2-Nov-83	36.23° N	34° E	14:34	15:04
2-Nov-83	36.16667° N	33.9° E	15:55	16:26
3-Nov-83	36.27667° N	33.89333° E	7:40	8:10
3-Nov-83	36.23° N	33.91° E	8:40	9:12
3-Nov-83	36.20333° N	33.84° E	9:47	10:20
3-Nov-83	36.16667° N	33.73° E	11:36	12:06
3-Nov-83	36.18333° N	33.64333° E	13:19	13:34

Continued

Table A1 continued

Date	Latitude	Longitude	Time (start)	Time (end)
3-Nov-83	36.14667° N	33.61667° E	14:00	14:15
3-Nov-83	36.14° N	33.5° E	15:27	15:42
3-Nov-83	36.15° N	33.46333° E	16:13	16:28
4-Nov-83	36.11333° N	33.33333° E	7:23	7:38
4-Nov-83	36.12167° N	33.16667° E	9:28	10:00
15-May-84	36.59167° N	34.325° E	10:30	11:00
15-May-84	36.615° N	34.34333° E	11:39	12:09
15-May-84	36.68667° N	34.50833° E	13:36	14:08
15-May-84	36.66667° N	34.59833° E	16:12	16:42
16-May-84	36.74667° N	34.84167° E	7:45	8:15
16-May-84	36.74° N	34.80333° E	8:52	9:26
16-May-84	36.71667° N	34.72833° E	10:59	11:29
16-May-84	36.61833° N	34.705° E	14:06	14:36
16-May-84	36.71333° N	34.66° E	15:55	16:25
19-May-84	36.69833° N	35° E	8:54	9:24
19-May-84	36.66667° N	34.99333° E	9:45	10:15
19-May-84	36.62333° N	34.93° E	11:19	11:49
19-May-84	36.52333° N	34.83333° E	13:24	13:54
19-May-84	36.535° N	35.10833° E	16:14	16:46
19-May-84	36.48333° N	35.26833° E	18:00	18:30
20-May-84	36.53667° N	35.455° E	7:31	8:01
20-May-84	36.50667° N	35.46° E	8:29	8:59
20-May-84	36.44333° N	35.48333° E	9:35	10:04
21-May-84	36.46° N	35.63° E	14:34	15:09
20-May-84	36.54833° N	35.71333° E	15:46	16:16
20-May-84	36.725° N	35.80167° E	17:14	17:44
21-May-84	36.82° N	35.88667° E	6:52	7:22
21-May-84	36.81667° N	35.96667° E	8:07	8:37
21-May-84	36.88333° N	36.085° E	10:10	10:40
21-May-84	36.86833° N	36.08833° E	11:17	11:49
21-May-84	36.73666° N	36.00666° E	14:48	15:18
21-May-84	36.65666° N	35.96333° E	16:35	16:55
22-May-84	36.67833° N	35.88333° E	7:25	7:34
22-May-84	36.615° N	35.77° E	8:28	8:58
22-May-84	36.64833° N	35.695° E	10:56	11:32
22-May-84	36.66667° N	35.66667° E	12:13	12:43
22-May-84	36.62° N	35.65333° E	13:16	13:46
23-May-84	36.39333° N	35.15167° E	8:17	8:47
25-May-84	36.52667° N	34.27333° E	10:39	11:32
29-May-84	36.42° N	34.13333° E	11:56	12:11
29-May-84	36.36667° N	34.09333° E	12:51	13:06
29-May-84	36.28167° N	34.08333° E	13:20	13:35
29-May-84	36.27833° N	34.05333° E	14:07	14:22
29-May-84	36.28333° N	34.02833° E	14:57	15:15
29-May-84	36.24167° N	34° E	15:58	16:15

Continued

Table A1 continued

Date	Latitude	Longitude	Time (start)	Time (end)
29-May-84	36.15333° N	33.86° E	17:26	17:41
30-May-84	36.25667° N	33.91333° E	6:17	6:32
30-May-84	36.24667° N	33.86667° E	7:08	7:23
30-May-84	36.19667° N	33.81333° E	8:00	8:19
30-May-84	36.15° N	33.76333° E	9:31	9:46
30-May-84	36.18333° N	33.64333° E	11:10	11:25
30-May-84	36.14667° N	33.61667° E	11:56	12:11
30-May-84	36.118182° N	33.498795° E	13:36	13:51
31-May-84	36.15° N	33.46333° E	6:58	7:13
31-May-84	36.11333° N	33.43333° E	7:48	8:04
31-May-84	36.11333° N	33.33333° E	9:32	9:47
31-May-84	36.12167° N	33.16667° E	11:58	12:09
31-May-84	36.05° N	33.03333° E	12:52	13:07
31-May-84	36.05° N	32.95° E	14:15	14:30
31-May-84	36.07167° N	32.98333° E	15:19	15:34
2-Jun-84	36.51333° N	34.21167° E	11:00	11:28
2-Jun-84	36.52333° N	34.23166° E	11:59	12:29
2-Jun-84	36.52667° N	34.24833° E	12:57	13:27
11-Oct-84	36.755° N	34.76667° E	7:25	7:55
11-Oct-84	36.75833° N	34.83333° E	8:35	9:05
11-Oct-84	36.68833° N	35.015° E	10:36	11:06
11-Oct-84	36.68167° N	34.96167° E	11:40	12:10
11-Oct-84	36.65167° N	34.86167° E	13:38	14:08
11-Oct-84	36.60833° N	34.76667° E	15:07	15:37
11-Oct-84	36.69167° N	34.77° E	16:28	16:58
12-Oct-84	36.53333° N	34.88167° E	9:49	10:19
12-Oct-84	36.49° N	35.02833° E	11:25	11:37
12-Oct-84	36.40833° N	35.04° E	13:43	14:43
12-Oct-84	36.37333° N	35.18333° E	15:15	15:45
13-Oct-84	36.48° N	35.41167° E	7:19	7:49
13-Oct-84	36.46333° N	35.51167° E	9:18	9:48
13-Oct-84	36.46° N	35.63° E	10:58	11:28
13-Oct-84	36.515° N	35.66667° E	12:30	13:00
13-Oct-84	36.575° N	35.74167° E	14:16	14:46
13-Oct-84	36.63833° N	35.785° E	15:30	16:00
14-Oct-84	36.68833° N	35.89667° E	7:30	8:00
14-Oct-84	36.745° N	36.045° E	9:25	9:55
14-Oct-84	36.87667° N	36.07° E	11:20	11:50
14-Oct-84	36.90167° N	36.06667° E	12:15	12:45
14-Oct-84	36.83794° N	35.97348° E	14:08	14:38
14-Oct-84	36.79° N	35.9° E	15:43	16:13
14-Oct-84	36.8° N	35.86667° E	16:38	17:08
15-Oct-84	36.735° N	35.83333° E	7:20	7:50
15-Oct-84	36.66667° N	35.71833° E	9:57	10:27
15-Oct-84	36.66667° N	35.66667° E	10:03	10:33

Continued

Table A1 continued

Date	Latitude	Longitude	Time (start)	Time (end)
15-Oct-84	36.63667° N	35.66667° E	10:49	11:19
15-Oct-84	36.56167° N	35.62° E	12:21	12:51
15-Oct-84	36.54833° N	35.47° E	13:37	14:07
15-Oct-84	36.57° N	35.43833° E	14:30	14:45
19-Oct-84	36.56667° N	35.04667° E	9:26	9:56
19-Oct-84	36.56333° N	35.02667° E	10:20	10:58
19-Oct-84	36.705° N	34.575° E	14:34	15:04
19-Oct-84	36.64333° N	34.54° E	16:00	16:30
24-Oct-84	36.40333° N	34.12167° E	11:34	11:54
27-Oct-84	36.51333° N	34.26167° E	6:42	7:12
27-Oct-84	36.51333° N	34.22333° E	8:32	9:02
27-Oct-84	36.36333° N	34.09333° E	12:18	12:33
27-Oct-84	36.29833° N	34.09° E	13:12	13:42
27-Oct-84	36.27833° N	34.06° E	14:02	14:42
27-Oct-84	36.29° N	34.05333° E	15:25	16:05
27-Oct-84	36.22167° N	34° E	17:10	17:25
28-Oct-84	36.27667° N	33.87333° E	7:25	7:50
28-Oct-84	36.24333° N	33.91667° E	9:01	9:21
28-Oct-84	36.15° N	33.83333° E	12:30	12:37
28-Oct-84	36.16667° N	33.73° E	13:59	14:29
28-Oct-84	36.22° N	33.83° E	15:48	16:18
29-Oct-84	36.18333° N	33.64333° E	9:30	9:45
29-Oct-84	36.14667° N	33.61667° E	10:10	10:25
29-Oct-84	36.14° N	33.5° E	11:45	12:00
29-Oct-84	36.15° N	33.46333° E	13:12	13:27
29-Oct-84	36.11333° N	33.43333° E	14:01	14:31
29-Oct-84	36.11333° N	33.33333° E	15:37	15:52
29-Oct-84	36.12167° N	33.16667° E	9:21	9:36
29-Oct-84	36.05833° N	33.05° E	10:49	11:04
29-Oct-84	36.08333 N	33.01° E	12:34	12:41
29-Oct-84	36.04909° N	32.97143° E	13:19	13:36
31-Oct-84	36.05° N	32.95° E	14:26	14:41
16-May-22	36.57086667° N	34.29185° E	9:23	9:53
16-May-22	36.56138333° N	34.3025167° E	10:38	11:08
17-May-22	36.57876667° N	34.2827667° E	9:16	9:46
18-May-22	36.44878333° N	34.14485° E	10:08	10:38
18-May-22	36.39795° N	34.1130667° E	12:11	12:41
19-May-22	36.65748333° N	34.5920167° E	9:03	9:33
19-May-22	36.63933333° N	34.4143667° E	14:03	14:33
19-May-22	36.71686667° N	34.5248333° E	15:37	16:07
20-May-22	36.7087° N	34.7650333° E	10:42	11:42
20-May-22	36.7899° N	34.80915° E	12:08	12:38
20-May-22	36.69311667° N	34.9591333° E	14:50	15:20
21-May-22	36.54066667° N	34.9178333° E	10:23	10:53
21-May-22	36.52811667° N	35.1162333° E	12:26	12:56

Continued

Table A1 continued

Date	Latitude	Longitude	Time (start)	Time (end)
21-May-22	36.58238333° N	35.2014167° E	13:55	14:10
21-May-22	36.45088333° N	35.3920333° E	16:05	16:35
21-May-22	36.48308333° N	35.42325° E	17:05	17:30
22-May-22	36.55156667° N	35.5090333° E	6:25	6:40
22-May-22	36.6402° N	35.6729167° E	8:11	8:26
22-May-22	36.64383333° N	35.7177167° E	9:21	9:46
22-May-22	36.67415° N	35.7121° E	10:21	10:51
22-May-22	36.772° N	35.862° E	12:06	12:36
23-May-22	36.80198333° N	36.05105° E	9:30	10:00
23-May-22	36.85331667° N	36.08525° E	10:48	11:03
23-May-22	36.87395° N	36.0830667° E	12:08	12:23
24-May-22	36.84833333° N	35.9221333° E	6:21	6:36
24-May-22	36.77635° N	35.9369667° E	7:38	8:08
26-May-22	36.29735° N	34.0627667° E	12:36	12:51
26-May-22	36.2718° N	33.9140333° E	14:54	15:09
26-May-22	36.25233333° N	33.8529667° E	16:03	16:33
27-May-22	36.15176667° N	33.64695° E	8:27	8:57
27-May-22	36.182° N	33.6494333° E	10:07	10:22
27-May-22	36.17908333° N	33.6102167° E	10:57	11:27
27-May-22	36.14481667° N	33.3301333° E	13:47	14:02
27-May-22	36.1399° N	33.3276° E	14:43	14:52
28-May-22	36.09761667° N	33.1506667° E	8:35	9:05
28-May-22	36.10998333° N	33.1365° E	10:32	10:48
28-May-22	36.12388333° N	33.1489167° E	11:45	12:01
28-May-22	36.08366667° N	33.0158333° E	13:24	13:54
28-May-22	36.08906667° N	33.0371° E	14:43	14:58
29-May-22	36.0708° N	33.0219167° E	7:39	8:09
29-May-22	36.1254° N	33.3695833° E	10:50	11:20
30-May-22	36.16478333° N	33.7865667° E	9:01	9:31
26-Sep-22	36.558° N	34.29945° E	9:44	10:14
26-Sep-22	36.5755° N	34.3004° E	11:33	12:03
27-Sep-22	36.56933333° N	34.27135° E	9:31	9:46
28-Sep-22	36.64128333° N	34.4185° E	10:30	11:00
28-Sep-22	36.71418333° N	34.5206333° E	13:21	13:36
28-Sep-22	36.65331667° N	34.55855° E	15:14	15:44
29-Sep-22	36.68133333° N	34.80325° E	11:21	11:51
29-Sep-22	36.71893333° N	34.8540667° E	12:32	12:47
29-Sep-22	36.69046667° N	34.94855° E	14:22	14:37
30-Sep-22	36.53086667° N	34.91985° E	10:21	10:51
30-Sep-22	36.52381667° N	35.1211° E	12:25	12:55
30-Sep-22	36.54435° N	35.2327333° E	14:05	14:20
30-Sep-22	36.52166667° N	35.4159167° E	15:35	15:50
1-Oct-22	36.49911667° N	35.4554333° E	8:06	8:36
1-Oct-22	36.4792° N	35.5037667° E	9:19	9:49
1-Oct-22	36.68778333° N	35.8419° E	12:34	12:56
1-Oct-22	36.77941667° N	36.02835° E	14:42	15:05

Continued

Table A1 continued

Date	Latitude	Longitude	Time (start)	Time (end)
1-Oct-22	36.86641667° N	36.0852833° E	16:13	16:28
2-Oct-22	36.83481667° N	36.0850833° E	7:29	7:59
2-Oct-22	36.85085° N	35.9219167° E	9:09	9:24
2-Oct-22	36.7868° N	35.8867333° E	10:07	10:37
2-Oct-22	36.6818° N	35.7354667° E	12:03	12:33
2-Oct-22	36.64358333° N	35.6839167° E	13:45	14:00
2-Oct-22	36.59385° N	35.7076167° E	14:47	15:17
5-Oct-22	36.44731667° N	34.1395333° E	10:49	11:19
5-Oct-22	36.29591667° N	34.0641833° E	13:55	14:10
5-Oct-22	36.25286667° N	33.8541667° E	16:20	16:35
6-Oct-22	36.27035° N	33.9097833° E	7:41	7:56
6-Oct-22	36.15351667° N	33.6421167° E	10:22	10:51
6-Oct-22	36.18358333° N	33.6197167° E	12:30	12:45
6-Oct-22	36.18091667° N	33.6119833° E	13:50	13:58
7-Oct-22	36.14065° N	33.3280333° E	7:32	7:53
7-Oct-22	36.14488333° N	33.3306167° E	8:47	9:02
7-Oct-22	36.12221667° N	33.3615667° E	10:13	10:41
7-Oct-22	36.10066667° N	33.1837° E	12:31	13:01
7-Oct-22	36.08338333° N	33.04595° E	14:50	15:14
8-Oct-22	36.08953333° N	33.0399667° E	7:48	8:03
8-Oct-22	36.0679 N	33.02855° E	9:23	9:53
8-Oct-22	36.1206° N	33.133° E	10:59	11:14
8-Oct-22	36.10646667° N	33.1282° E	11:49	12:19
9-Oct-22	36.16166667° N	33.7916° E	10:16	10:46
9-Oct-22	36.38916667° N	34.1071° E	13:50	14:20

Table A2. The number of species and NIS, recorded mean CPUA (kg/km²) per station, and the percentage of NIS in the total catch, recorded on the continental shelf of the Northeastern Mediterranean Sea.

Period	#Hauls	Σ Teleost	Σ NIS	CPUA (kg/km2)	% NIS
Aut 1983	50	66	13	868.0652	36.6
Spr 1984	58	70	13	753.212	24.9
Aut 1984	57	73	13	971.7733	52.4
Spr 2022	42	106	32	2928.43	92.3
Aut 2022	42	106	34	2446.423	82.7

Table A3. Identified groups, the number of IS and NIS, the percentage contribution of biomass of IS and NIS recorded in these groups, and total CPUA (= Catch per unit area in kg/km^2).

Period	Groups	# IS	#NIS	% IS	% NIS	CPUA (kg/km2)
Aut 1983	Sh	39	13	37.7	62.3	686.6529
Aut 1983	D	35	9	82.7	17.3	1182.6030
Aut 1983	S	14	6	57.1	42.9	422.0155
Aut 1983	A	8	4	38.0	62.0	322.8976
Aut 1983	W	32	9	52.6	47.4	717.3148
Spr 1984	CD	52	11	71.3	28.7	673.0883
Spr 1984	Mc	11	0	100.0	0.0	770.0201
Spr 1984	Ec	4	1	13.3	86.7	825.0153
Spr 1984	A	11	7	82.3	17.7	133.3945
Spr 1984	W	30	6	89.8	10.2	1907.5899
Aut 1984	Sh	50	13	26.6	73.4	1138.7207
Aut 1984	D	42	9	77.3	22.7	852.5079
Aut 1984	I	13	5	20.8	79.2	334.8725
Aut 1984	Wc	15	4	95.5	4.5	2956.1174
Aut 1984	W	19	4	65.2	34.8	228.0587
Spr 2022	D	34	22	43.1	56.9	639.0528
Spr 2022	L	9	8	15.5	84.5	445.00116
Spr 2022	Sh	44	26	3.5	96.5	5810.2186
Spr 2022	Ec	7	4	26.9	73.1	134.4256
Spr 2022	W	34	23	55.7	44.3	439.1080
Aut 2022	D	50	23	73.3	26.7	888.4288
Aut 2022	Sh	31	26	7.9	92.1	4129.3507
Aut 2022	Ed	3	11	3.8	96.2	233.7087
Aut 2022	W	27	23	63.7	36.3	549.2380
Aut 2022	X	17	9	52.1	47.9	1293.8670

Table A4. The top 15 species of the highest biomass in autumn 1983 (CPUA = Catch per unit area in kg/km2, % = percentage biomass).

Shallow			Deep		
CPUA (kg/km2)	%	Species	CPUA (kg/km2)	%	Species
203.63	29.7	*Equulites klunzingeri*	232.18	19.6	*Mullus barbatus*
177.39	25.8	*Saurida lessepsianus*	172.22	14.6	*Boops boops*
114.12	16.6	*Mullus barbatus*	161.67	13.7	*Saurida lessepsianus*
24.49	3.6	*Stephanolepis diaspros*	104.2	8.8	*Citharus linguatula*
23.78	3.5	*Chelidonichthys lucerna*	95.62	8.1	*Lepidotrigla cavillone*
20.49	3	*Pagellus erythrinus*	71.08	6	*Pagellus erythrinus*
18.12	2.6	*Argyrosomus regius*	49.08	4.1	*Pagellus acarne*
11.9	1.7	*Diplodus annularis*	45.77	3.9	*Chelidonichthys lucerna*
11.7	1.7	*Pomadasys incisus*	40.34	3.4	*Arnoglossus laterna*
9.78	1.4	*Arnoglossus laterna*	32.98	2.8	*Spicara maena*
9.26	1.3	*Solea solea*	32.12	2.7	*Uranoscopus scaber*
7.23	1.1	*Upeneus moluccensis*	19.68	1.7	*Equulites klunzingeri*
6.83	1	*Gobius niger*	16.91	1.4	*Upeneus moluccensis*
5.94	0.9	*Mullus surmuletus*	16.13	1.4	*Solea solea*
4.7	0.7	*Sparus aurata*	10.98	0.9	*Serranus hepatus*
Akyayan Lake			West of Mersin Bay		
CPUA (kg/km2)	%	Species	CPUA (kg/km2)	%	Species
141.91	43.9	*Siganus rivulatus*	239.94	33.4	*Saurida lessepsianus*
56.76	17.6	*Stephanolepis diaspros*	86.62	12.1	*Stephanolepis diaspros*
48.03	14.9	*Mullus barbatus*	64.67	9	*Mullus barbatus*
41.48	12.8	*Pagellus erythrinus*	44.2	6.2	*Pagrus pagrus*
19.65	6.1	*Diplodus annularis*	43.91	6.1	*Epinephelus aeneus*
7.86	2.4	*Sparus aurata*	40.97	5.7	*Pagellus erythrinus*
2.40	0.7	*Lithognathus mormyrus*	37.11	5.2	*Bothus podas*
1.75	0.5	*Mullus surmuletus*	35.01	4.9	*Lepidotrigla cavillone*
0.87	0.3	*Callionymus filamentosus*	22.56	3.1	*Chelidonichthys lucerna*
0.87	0.3	*Spicara maena*	18.13	2.5	*Dentex dentex*
0.65	0.2	*Equulites klunzingeri*	10.92	1.5	*Arnoglossus laterna*
0.655	0.2	*Bothus podas*	9.78	1.4	*Diplodus vulgaris*
			8.74	1.2	*Mullus surmuletus*
			8.49	1.2	*Scorpaena porcus*
			7.89	1.1	*Equulites klunzingeri*
Seyhan					
CPUA (kg/km2)	%	Species			
110.6	26.2	*Mullus barbatus*			
97.33	23.1	*Equulites klunzingeri*			
57.5	13.6	*Stephanolepis diaspros*			
29.19	6.9	*Chelidonichthys lucerna*			
23.01	5.5	*Oblada melanurus*			
17.71	4.2	*Sparus aurata*			
16.11	3.8	*Siganus rivulatus*			
15.04	3.6	*Lithognathus mormyrus*			
13.27	3.1	*Argyrosomus regius*			
12.38	2.9	*Diplodus vulgaris*			
4.87	1.2	*Siganus luridus*			
4.43	1.1	*Mullus surmuletus*			
4.43	1.1	*Solea solea*			
3.97	0.9	*Diplodus sargus*			
3.53	0.8	*Apogonichthyoides nigripinnis*			

Table A5. PERMUTEST results testing for differences in the dispersions of species composition in the clusters, regions, and depths (number of permutations: 999).

Aut 1983						
	Df	Sum Sq	Mean Sq	F	N.Perm	Pr(>F)
Cluster	2	0.006817	0.0034084	1.6363	999	0.212
Residuals	45	0.093731	0.0020829			
Region	2	0.013221	0.0066106	1.8169	999	0.176
Residuals	47	0.0171003	0.003684			
Depth	2	0.021995	0.010998	3.7857	999	**0.025***
Residuals	47	0.136536	0.002905			
Spr 1984						
Cluster	1	0.004066	0.0040661	1.2309	999	0.278
Residuals	53	0.175076	0.0033033			
Region	2	0.03947	0.0197370	3.0652	999	**0.049***
Residuals	55	0.35415	0.0064391			
Depth	2	0.03481	0.0174026	2.4346	999	0.094
Residuals	55	0.39314	0.0071481			
Aut 1984						
Cluster	3	0.01607	0.0053566	2.3596	999	0.08
Residuals	52	0.11804	0.0022701			
Region	2	0.013016	0.0065078	1.2396	999	0.313
Residuals	54	0.283493	0.0052499			
Depth	2	0.02012	0.0100603	1.5239	999	0.221
Residuals	54	0.35648	0.0066015			
Spr 2022						
Cluster	2	0.00104	0.0005198	0.1213	999	0.896
Residuals	37	0.15856	0.0042853			
Region	2	0.009673	0.0048365	0.8231	999	0.438
Residuals	39	0.229167	0.0058761			
Depth	2	0.03648	0.0182401	2.3749	999	0.107
Residuals	39	0.29954	0.0076804			
Aut 2022						
Cluster	2	0.011722	0.0058609	2.3292	999	0.123
Residuals	37	0.093103	0.0025163			
Region	2	0.031426	0.015713	2.0569	999	0.152
Residuals	39	0.297922	0.007639			
Depth	2	0.02028	0.0101376	1.1752	999	0.339
Residuals	39	0.33643	0.008626			
Signif. codes	0 '***'	0.001 '**'	0.01 '*'	0.05 '.'	0.1 ' '	1

Table A6. PERMANOVA results testing for differences in species composition regarding to cluster, region, and depth.

Aut 1983					
	Df	SumOfSqs	R2	F	Pr(>F)
Cluster	2	1.9059	0.32336	10.753	0.001***
Residuals	45	3.9882	0.67664		
Total	47	5.8941	1.00000		
Region	2	0.8789	0.13522	4.7871	0.001***
Depth	2	1.4900	0.22924	8.1157	0.001***
Residuals	45	4.1310	0.63554		
Total	49	6.5000	1.00000		
Spr 1984					
Cluster	1	1.0054	0.15199	9.4991	0.001***
Residuals	53	5.6097	0.84801		
Total	54	6.6151	1.00000		
Region	2	1.2871	0.16405	6.9927	0.001***
Depth	2	1.6809	0.21425	9.1323	0.001***
Residuals	53	4.8776	0.62170		
Total	57	7.8456	1.00000		
Aut 1984					
Cluster	3	4.0366	0.42037	12.571	0.001***
Residuals	53	5.5659	0.57963		
Total	55	9.6025	1.00000		
Region	2	1.1394	0.11245	5.0415	0.001***
Depth	2	3.1171	0.30764	13.7928	0.001***
Residuals	52	5.8759	0.59991		
Total	56	10.1324	1.00000		
Spr 2022					
	Df	SumOfSqs	R2	F	Pr(>F)
Cluster	2	3.5584	0.25154	6.2174	0.001***
Residuals	37	10.5882	0.74846		
Total	39	14.1466	1.00000		
Region	2	2.1729	0.14456	3.7865	0.001***
Depth	2	2.2419	0.14915	3.9067	0.001***
Residuals	37	10.6163	0.70629		
Total	41	15.0311	1.00000		
Aut 2022					
Cluster	2	3.1755	0.30224	8.0133	0.001***
Residuals	37	7.3313	0.69776		
Total	39	10.5068	1.00000		
Region	2	1.3058	0.16960	10.670	0.001***
Depth	2	1.6205	0.21049	13.242	0.001***
Residuals	37	4.77727	0.61991		
Total	41	7.6990	1.00000		

Table A7. Similarity percentage analysis results show the significant average contribution of species to the average dissimilarity between observations from the two groups in autumn 1983.

Species	average	sd	ratio	ava	avb	cumsum	p	stat
Pomadasys stridens	0.038	0.018	2.154	1.272	5.917	0.053	0.001	D_Sh
Sparus aurata	0.028	0.014	2.009	0.288	3.704	0.092	0.001	D_Sh
Equulites klunzingeri	0.023	0.018	1.248	0.454	2.999	0.124	0.002	D_Sh
Fistularia petimba	0.02	0.017	1.188	2.571	0.815	0.18	0.013	D_Sh
Lepidotrigla cavillone	0.02	0.015	1.386	2.643	0.161	0.152	0.001	D_Sh
Torquigener hypselogeneion	0.018	0.012	1.489	2.991	1.123	0.233	0.001	D_Sh
Pagellus erythrinus	0.018	0.013	1.352	2.866	1.278	0.258	0.008	D_Sh
Upeneus moluccensis	0.017	0.014	1.199	2.522	1.633	0.378	0.042	D_Sh
Sphyraena chrysotaenia	0.017	0.017	0.954	0.258	2.189	0.401	0.007	D_Sh
Chelidonichthys lastoviza	0.017	0.014	1.222	2.243	0	0.33	0.001	D_Sh
Trachurus mediterraneus	0.017	0.014	1.213	0.48	2.369	0.282	0.002	D_Sh
Caranx rhonchus	0.017	0.016	1.108	0	2.19	0.354	0.002	D_Sh
Trichiurus lepturus	0.017	0.015	1.116	0	2.197	0.306	0.001	D_Sh
Ostorhinchus fasciatus	0.016	0.013	1.255	2.745	1.511	0.424	0.025	D_Sh
Citharus linguatula	0.016	0.015	1.051	1.975	0.613	0.49	0.005	D_Sh
Zeus faber	0.016	0.013	1.213	2.062	0.118	0.468	0.001	D_Sh
Argyrosomus regius	0.013	0.018	0.739	0	1.651	0.567	0.019	D_Sh
Serranus hepatus	0.013	0.014	0.973	1.683	0.245	0.548	0.011	D_Sh
Chelidonichthys lucerna	0.012	0.014	0.818	0.295	1.349	0.617	0.022	D_Sh
Solea solea	0.012	0.015	0.824	0	1.602	0.584	0.015	D_Sh
Spicara flexuosum	0.01	0.014	0.718	1.291	0	0.723	0.008	D_Sh
Jaydia smithi	0.006	0.01	0.58	0	0.683	0.834	0.049	D_Sh
Monochirus hispidus	0.004	0.007	0.5	0.477	0	0.91	0.029	D_Sh
Blennius ocellaris	0.004	0.007	0.511	0.506	0	0.914	0.027	D_Sh
Upeneus pori	0.028	0.014	1.966	0.265	3.801	0.039	0.001	D_W
Parupeneus forsskali	0.027	0.013	2.098	0.213	3.718	0.076	0.001	D_W
Bothus podas	0.025	0.014	1.714	0.577	3.451	0.11	0.001	D_W
Siganus rivulatus	0.021	0.014	1.525	0	2.822	0.139	0.001	D_W
Stephanolepis diaspros	0.02	0.014	1.447	0.439	2.895	0.167	0.001	D_W
Ostorhinchus fasciatus	0.02	0.011	1.813	2.745	0.22	0.249	0.004	D_W
Pteragogus trispilus	0.02	0.013	1.525	0.173	2.757	0.222	0.001	D_W
Epinephelus aeneus	0.02	0.018	1.105	0.417	2.481	0.195	0.013	D_W
Lepidotrigla cavillone	0.019	0.013	1.456	2.643	0	0.276	0.011	D_W
Saurida lessepsianus	0.018	0.015	1.181	4.567	2.312	0.376	0.002	D_W
Lagocephalus suezensis	0.018	0.016	1.106	0.826	2.332	0.425	0.013	D_W
Upeneus moluccensis	0.018	0.013	1.426	2.522	0.606	0.351	0.046	D_W
Serranus cabrilla	0.018	0.015	1.226	1.299	2.753	0.327	0.003	D_W
Pterois miles	0.017	0.014	1.217	1.4	2.682	0.471	0.015	D_W
Chelidonichthys lastoviza	0.015	0.012	1.221	2.243	0.875	0.536	0.047	D_W

Continued

Table A7 continued

Species	average	sd	ratio	ava	avb	cumsum	p	stat
Zeus faber	0.015	0.012	1.246	2.062	0.319	0.576	0.033	D_W
Coris julis	0.013	0.012	1.122	0	1.765	0.649	0.001	D_W
Equulites popei	0.012	0.015	0.768	0.828	1.149	0.683	0.031	D_W
Apogonichthyoides nigripinnis	0.01	0.012	0.849	0	1.447	0.726	0.001	D_W
Spicara smaris	0.009	0.012	0.781	0.678	0.966	0.739	0.032	D_W
Serranus scriba	0.008	0.014	0.615	0	1.222	0.751	0.003	D_W
Spondyliosoma cantharus	0.007	0.011	0.623	0	1.024	0.814	0.003	D_W
Symphodus tinca	0.007	0.011	0.623	0	1.024	0.824	0.003	D_W
Lagocephalus sceleratus	0.005	0.011	0.402	0	0.566	0.881	0.006	D_W
Diplodus vulgaris	0.005	0.013	0.403	0	0.805	0.875	0.011	D_W
Scorpaena porcus	0.004	0.011	0.403	0	0.665	0.887	0.011	D_W
Symphodus mediterraneus	0.004	0.01	0.403	0	0.574	0.921	0.011	D_W
Muraena helena	0.004	0.011	0.403	0	0.595	0.905	0.007	D_W
Sparisoma cretense	0.004	0.011	0.403	0	0.665	0.893	0.011	D_W
Symphodus roissali	0.004	0.01	0.403	0	0.576	0.916	0.011	D_W
Xyrichtys novacula	0.004	0.01	0.403	0	0.534	0.911	0.005	D_W
Callionymus maculatus	0.004	0.008	0.479	0.162	0.405	0.932	0.033	D_W
Jaydia queketti	0.003	0.007	0.402	0	0.362	0.958	0.006	D_W
Gobius niger	0.003	0.007	0.403	0	0.362	0.965	0.005	D_W
Engraulis encrasicolus	0.002	0.005	0.403	0	0.263	0.984	0.005	D_W
Pomadasys stridens	0.033	0.014	2.358	5.917	1.118	0.042	0.006	Sh_W
Parupeneus forsskali	0.026	0.012	2.136	0.152	3.718	0.106	0.001	Sh_W
Sparus aurata	0.026	0.01	2.547	3.704	0	0.074	0.002	Sh_W
Bothus podas	0.023	0.012	1.973	0.302	3.451	0.135	0.001	Sh_W
Upeneus pori	0.021	0.015	1.409	1.318	3.801	0.161	0.009	Sh_W
Stephanolepis diaspros	0.02	0.013	1.523	0	2.895	0.186	0.001	Sh_W
Serranus cabrilla	0.02	0.013	1.5	0	2.753	0.235	0.001	Sh_W
Pteragogus trispilus	0.019	0.013	1.509	0	2.757	0.258	0.001	Sh_W
Siganus rivulatus	0.019	0.013	1.441	0.383	2.822	0.281	0.003	Sh_W
Saurida lessepsianus	0.018	0.014	1.251	4.592	2.312	0.327	0.003	Sh_W
Pterois miles	0.018	0.013	1.401	0.214	2.682	0.304	0.004	Sh_W
Torquigener hypselogeneion	0.016	0.012	1.433	1.123	3.028	0.414	0.014	Sh_W
Lagocephalus suezensis	0.016	0.015	1.092	0.721	2.332	0.434	0.045	Sh_W
Coris julis	0.012	0.011	1.12	0	1.765	0.609	0.001	Sh_W
Apogonichthyoides nigripinnis	0.01	0.011	0.848	0	1.447	0.689	0.005	Sh_W
Serranus scriba	0.008	0.013	0.614	0	1.222	0.785	0.029	Sh_W
Spondyliosoma cantharus	0.007	0.011	0.623	0	1.024	0.82	0.029	Sh_W
Symphodus tinca	0.007	0.011	0.623	0	1.024	0.828	0.029	Sh_W

Table A8. The top 15 species of the highest biomass in spring 1984 (CPUA = Catch per unit area in kg/km^2, % = percentage biomass).

Coastal-Deep			**West of Seyhan River**		
CPUA (kg/km2)	**%**	**Species**	**CPUA (kg/km2)**	**%**	**Species**
138.4	20.6	*Saurida lessepsianus*	499.96	64.9	*Argyrosomus regius*
106.29	15.8	*Mullus barbatus*	115.71	15	*Spicara maena*
87.12	12.9	*Lepidotrigla cavillone*	85.15	11.1	*Solea solea*
44.53	6.6	*Pagellus erythrinus*	13.1	2.6	*Trichiurus lepturus*
30.69	4.6	*Chelidonichthys lucerna*	13.1	1.7	*Lepidotrigla cavillone*
29.91	4.4	*Arnoglossus laterna*	12.66	1.6	*Arnoglossus laterna*
29.42	4.4	*Spicara maena*	10.48	1.4	*Umbrina cirrosa*
29.36	4.4	*Citharus linguatula*	7.86	1	*Pomadasys incisus*
22.65	3.4	*Equulites klunzingeri*	4.15	0.5	*Engraulis encrasicolus*
20.45	3	*Bothus podas*	1.09	0.1	*Diplodus vulgaris*
19.84	2.9	*Upeneus moluccensis*	0.22	0	*Gobius niger*
13.67	2	*Merluccius merluccius*			
12.86	1.9	*Uranoscopus scaber*			
12.21	1.8	*Solea solea*			
6.68	1	*Serranus hepatus*			
Eastern coast			Akyayan		
CPUA (kg/km2)	%	Species	CPUA (kg/km2)	%	Species
380.84	46.2	*Sparus aurata*	115.71	86.7	*Equulites klunzingeri*
89.62	10.9	*Diplodus annularis*	10.92	8.2	*Chelidonichthys lucerna*
76.17	9.2	*Pelates quadrilineatus*	3.06	2.3	*Spicara maena*
67.68	8.2	*Mugil cephalus*	2.18	1.6	*Trachurus trachurus*
49.3	6	*Lithognathus mormyrus*	1.53	1.1	*Arnoglossus laterna*
31.37	3.8	*Siganus rivulatus*			
31.37	3.8	*Trachurus trachurus*			
24.65	3	*Chelidonichthys lucerna*			
17.92	2.2	*Diplodus vulgaris*			
15.68	1.9	*Equulites klunzingeri*			
11.2	1.4	*Sillago suezensis*			
8.95	1.1	*Upeneus pori*			
8.73	1.1	*Solea solea*			
4.48	0.5	*Pagellus acarne*			
2.25	0.3	*Stephanolepis diaspros*			
West of Mersin Bay					
CPUA (kg/km2)	%	Species			
502.44	26.3	*Mullus barbatus*			
349.31	18.3	*Pagrus pagrus*			
167.53	8.8	*Stephanolepis diaspros*			
122.06	6.4	*Diplodus vulgaris*			

Continued

Table A8 continued

Coastal-Deep			West of Seyhan River
117.89	6.2	*Dentex dentex*	
105.98	5.6	*Pagellus erythrinus*	
74.23	3.9	*Serranus cabrilla*	
68.27	3.6	*Scorpaena notata*	
65.3	3.4	*Mullus surmuletus*	
54.388	2.9	*Diplodus annularis*	
51.82	2.7	*Chelidonichthys lastoviza*	
33.84	1.8	*Diplodus sargus*	
3.17	1.6	*Spicara maena*	
22.09	1.2	*Bothus podas*	
16.37	0.9	*Uranoscopus scaber*	

Table A9. Similarity percentage analysis results showing the significant average contribution of each species to the average dissimilarity between observations from the two groups in spring 1984.

Species	average	sd	ratio	ava	avb	cumsum	p	stat
Stephanolepis diaspros	0.023	0.012	1.872	1.222	4.779	0.253	0.002	Cd_W
Saurida lessepsianus	0.018	0.014	1.251	4.891	2.204	0.46	0.004	Cd_W
Siganus rivulatus	0.007	0.012	0.572	0	1.105	0.927	0.004	Cd_W
Diplodus annularis	0.019	0.013	1.45	0.961	3.539	0.316	0.022	Cd_W
Serranus cabrilla	0.019	0.013	1.416	1.17	3.626	0.375	0.014	Cd_W
Diplodus vulgaris	0.03	0.008	3.896	0.292	5.004	0.096	0.001	Cd_W
Chelidonichthys lastoviza	0.021	0.013	1.647	1.334	4.568	0.286	0.002	Cd_W
Dentex dentex	0.017	0.017	0.984	0	2.627	0.567	0.002	Cd_W
Dentex gibbosus	0.014	0.014	0.989	0.471	2.124	0.636	0.017	Cd_W
Gobius niger	0.017	0.01	1.724	2.757	0	0.514	0.019	Cd_W
Mullus surmuletus	0.029	0.008	3.831	0.095	4.598	0.14	0.001	Cd_W
Bothus podas	0.024	0.01	2.307	0.822	4.321	0.218	0.002	Cd_W
Pagrus pagrus	0.032	0.009	3.488	0.384	5.417	0.05	0.001	Cd_W
Scorpaena notata	0.027	0.009	3.06	0.379	4.531	0.182	0.002	Cd_W
Diplodus sargus	0.008	0.014	0.572	0	1.283	0.893	0.004	Cd_W

Table A10. The top 15 species of the highest biomass in autumn 1984 (CPUA = Catch per unit area in kg/km^2, % = percentage biomass)

Shallow			Deep		
CPUA (kg/km2)	**%**	**Species**	**CPUA (kg/km2)**	**%**	**Species**
458.41	40.3	*Equulites klunzingeri*	182.67	21.4	*Mullus barbatus*
236.89	20.8	*Saurida lessepsianus*	163.59	19.2	*Saurida lessepsianus*
63.51	5.6	*Mullus barbatus*	99.38	11.7	*Lepidotrigla cavillone*
48.63	4.3	*Upeneus moluccensis*	81.43	9.6	*Citharus linguatula*
42.8	3.8	*Pagellus erythrinus*	67.78	8	*Merluccius merluccius*
36.68	3.2	*Stephanolepis diaspros*	61.57	7.2	*Pagellus erythrinus*
33.28	2.9	*Argyrosomus regius*	28.42	3.3	*Uranoscopus scaber*
18.55	1.6	*Epinephelus aeneus*	27.82	3.3	*Upeneus moluccensis*
18.31	1.6	*Upeneus pori*	27.32	3.2	*Spicara maena*
18.02	1.6	*Arnoglossus laterna*	22.73	2.7	*Arnoglossus laterna*
17.06	1.5	*Pelates quadrilineatus*	12.85	1.5	*Chelidonichthys lastoviza*
14.76	1.3	*Bothus podas*	9.91	1.2	*Chelidonichthys lucerna*
14.66	1.3	*Diplodus annularis*	7.83	0.9	*Serranus hepatus*
10.83	1	*Sparus aurata*	6.82	0.8	*Boops boops*
9.73	0.9	*Gobius niger*	5.72	0.7	*Zeus faber*
Intermediate			West coast		
CPUA (kg/km2)	%	Species	CPUA (kg/km2)	%	Species
216.68	64.7	*Saurida lessepsianus*	1250.98	42.3	*Diplodus sargus*
38.77	11.6	*Equulites klunzingeri*	1231.33	41.7	*Sparus aurata*
26.42	7.9	*Citharus linguatula*	127.72	4.3	*Stephanolepis diaspros*
14.74	4.4	*Uranoscopus scaber*	85.15	2.9	*Bothus podas*
10.64	3.2	*Chelidonichthys lucerna*	68.77	2.3	*Pagrus pagrus*
6.33	1.9	*Upeneus moluccensis*	62.22	2.1	*Dentex dentex*
4.58	1.4	*Arnoglossus laterna*	39.3	1.3	*Xyrichtys novacula*
3.27	1	*Sphyraena chrysotaenia*	22.92	0.8	*Synodus saurus*
3.27	1	*Mullus barbatus*	19.65	0.7	*Mullus surmuletus*
2.95	0.9	*Trachurus trachurus*	13.1	0.4	*Scorpaena scrofa*
2.73	0.8	*Argyrosomus regius*	9.82	0.3	*Dentex gibbosus*
1.86	0.6	*Boops boops*	9.82	0.3	*Balistes capriscus*
1.09	0.3	*Epinephelus aeneus*	6.55	0.2	*Chelidonichthys lastoviza*
0.55	0.2	*Sardinella aurita*	2.62	0.1	*Siganus rivulatus*
0.33	0.1	*Gobius niger*	2.29	0.1	*Pagrus auriga*
West of Mersin Bay					
CPUA (kg/km2)	%	Species			
70.74	31	*Dentex macrophthalmus*			
60.69	26.6	*Stephanolepis diaspros*			
11.13	10.3	*Trachinus draco*			
8.73	4.9	*Chelidonichthys lastoviza*			

Continued

Table A10 continued

Shallow			Deep
7.42	3.8	*Saurida lessepsianus*	
5.24	3.3	*Chelidonichthys lucerna*	
5.24	2.3	*Upeneus pori*	
5.24	2.3	*Pagellus erythrinus*	
5.24	2.3	*Dentex dentex*	
5.24	2.3	*Zeus faber*	
4.8	2.1	*Siganus rivulatus*	
3.93	1.7	*Synodus saurus*	
3.06	1.3	*Serranus cabrilla*	
3.06	1.3	*Macroramphosus scolopax*	
2.18	1	*Bothus podas*	

Table A11. Similarity percentage analysis results showing the significant average contribution of each species to the average dissimilarity between observations from the two groups in autumn 1984.

Species	average	sd	ratio	ava	avb	cumsum	p	stat
Pagellus erythrinus	0.039	0.012	3.16	4.287	0	0.063	0.001	D_I
Mullus barbatus	0.032	0.021	1.498	4.103	1.029	0.114	0.001	D_I
Lepidotrigla cavillone	0.031	0.016	2.019	4.089	0.735	0.165	0.001	D_I
Sphyraena chrysotaenia	0.03	0.009	3.192	0.142	3.277	0.261	0.001	D_I
Serranus hepatus	0.03	0.015	2.003	3.203	0	0.213	0.001	D_I
Spicara maena	0.027	0.018	1.456	3.03	0	0.305	0.001	D_I
Merluccius merluccius	0.027	0.022	1.236	2.986	0	0.348	0.002	D_I
Blennius ocellaris	0.022	0.014	1.555	2.502	0	0.419	0.001	D_I
Uranoscopus scaber	0.022	0.019	1.167	2.537	1.193	0.384	0.013	D_I
Chelidonichthys lastoviza	0.021	0.018	1.205	2.484	0	0.454	0.009	D_I
Trachurus trachurus	0.02	0.017	1.228	1.25	2.66	0.487	0.005	D_I
Zeus faber	0.019	0.017	1.128	2.18	0	0.518	0.014	D_I
Boops boops	0.017	0.017	1.034	1.395	1.775	0.605	0.02	D_I
Scorpaena porcus	0.016	0.015	1.075	1.943	0	0.687	0.03	D_I
Sardinella aurita	0.008	0.014	0.596	0.147	0.835	0.865	0.027	D_I
Citharus linguatula	0.037	0.01	3.748	4.647	0	0.058	0.001	D_W
Dentex macrophthalmus	0.032	0.017	1.916	0.879	4.774	0.107	0.005	D_W
Lepidotrigla cavillone	0.031	0.012	2.549	4.089	0	0.155	0.002	D_W
Stephanolepis diaspros	0.028	0.016	1.785	1.247	4.662	0.199	0.002	D_W
Upeneus pori	0.027	0.008	3.193	0.233	3.592	0.24	0.001	D_W
Upeneus moluccensis	0.024	0.015	1.575	3.114	0	0.277	0.027	D_W
Arnoglossus laterna	0.023	0.017	1.297	4.184	1.621	0.385	0.016	D_W
Blennius ocellaris	0.019	0.013	1.502	2.502	0	0.414	0.042	D_W
Gobius niger	0.018	0.013	1.442	2.346	0	0.443	0.047	D_W
Macroramphosus scolopax	0.017	0.018	0.961	0.134	1.893	0.497	0.041	D_W
Trachinus draco	0.016	0.016	0.991	0.366	2.337	0.628	0.02	D_W
Synodus saurus	0.014	0.014	0.984	0.717	1.948	0.72	0.022	D_W
Dentex dentex	0.013	0.014	0.97	0	2.01	0.762	0.018	D_W
Microlipophrys dalmatinus	0.009	0.009	0.97	0	1.321	0.895	0.018	D_W
Dentex macrophthalmus	0.054	0.016	3.381	0	4.774	0.062	0.001	I_W
Stephanolepis diaspros	0.051	0.009	5.897	0	4.662	0.12	0.001	I_W
Chelidonichthys lastoviza	0.044	0.016	2.748	0	3.821	0.221	0.001	I_W
Citharus linguatula	0.044	0.016	2.83	3.936	0	0.171	0.002	I_W
Pagellus erythrinus	0.041	0.014	2.974	0	3.592	0.267	0.004	I_W
Saurida lessepsianus	0.039	0.033	1.176	5.199	2.121	0.312	0.003	I_W
Serranus cabrilla	0.039	0.01	3.859	0	3.481	0.357	0.004	I_W
Sphyraena chrysotaenia	0.036	0.01	3.633	3.277	0	0.398	0.001	I_W
Spicara maena	0.035	0.01	3.458	0	3.092	0.438	0.005	I_W
Upeneus moluccensis	0.033	0.022	1.457	2.886	0	0.476	0.01	I_W

Continued

Table A11 continued

Species	average	sd	ratio	ava	avb	cumsum	p	stat
Upeneus pori	0.032	0.015	2.135	0.66	3.592	0.512	0.003	I_W
Trachurus trachurus	0.029	0.019	1.486	2.66	0	0.578	0.001	I_W
Mullus barbatus	0.029	0.012	2.358	1.029	3.132	0.545	0.037	I_W
Macroramphosus scolopax	0.026	0.027	0.931	0	1.893	0.667	0.001	I_W
Arnoglossus laterna	0.026	0.025	1.055	3.623	1.621	0.608	0.011	I_W
Scorpaena scrofa	0.02	0.021	0.931	0	1.471	0.762	0.003	I_W
Trachinus draco	0.02	0.022	0.934	0	2.337	0.739	0.006	I_W
Dentex dentex	0.018	0.019	0.934	0	2.01	0.826	0.001	I_W
Synodus saurus	0.017	0.018	0.934	0	1.948	0.886	0.018	I_W
Microlipophrys dalmatinus	0.012	0.012	0.934	0	1.321	0.933	0.001	I_W
Equulites klunzingeri	0.031	0.013	2.503	5.082	0.615	0.049	0.001	Sh_D
Lepidotrigla cavillone	0.027	0.011	2.48	0.144	4.089	0.09	0.001	Sh_D
Citharus linguatula	0.023	0.015	1.59	1.417	4.647	0.126	0.001	Sh_D
Spicara maena	0.02	0.014	1.434	0.231	3.03	0.188	0.001	Sh_D
Merluccius merluccius	0.02	0.016	1.244	0.249	2.986	0.157	0.001	Sh_D
Epinephelus aeneus	0.019	0.015	1.254	2.722	0	0.216	0.001	Sh_D
Upeneus pori	0.017	0.012	1.422	2.67	0.233	0.243	0.001	Sh_D
Blennius ocellaris	0.017	0.011	1.557	0	2.502	0.295	0.001	Sh_D
Solea solea	0.017	0.012	1.369	2.875	1.245	0.269	0.007	Sh_D
Chelidonichthys lastoviza	0.016	0.013	1.21	0.114	2.484	0.346	0.001	Sh_D
Uranoscopus scaber	0.016	0.014	1.188	0.569	2.537	0.32	0.005	Sh_D
Argyrosomus regius	0.016	0.017	0.938	2.275	0	0.444	0.012	Sh_D
Serranus hepatus	0.016	0.012	1.357	1.284	3.203	0.395	0.013	Sh_D
Callionymus filamentosus	0.015	0.012	1.311	2.592	0.86	0.467	0.012	Sh_D
Zeus faber	0.014	0.013	1.138	0.091	2.18	0.49	0.002	Sh_D
Diplodus annularis	0.014	0.014	1.028	2.146	0	0.556	0.003	Sh_D
Serranus cabrilla	0.014	0.014	1.04	0.62	2.086	0.534	0.037	Sh_D
Scorpaena porcus	0.013	0.012	1.069	0.159	1.943	0.616	0.002	Sh_D
Pomadasys incisus	0.012	0.014	0.875	1.818	0	0.654	0.008	Sh_D
Lagocephalus spadiceus	0.011	0.013	0.879	1.622	0	0.69	0.004	Sh_D
Balistes capriscus	0.01	0.013	0.777	1.541	0	0.722	0.022	Sh_D
Pagellus acarne	0.009	0.012	0.754	0.094	1.397	0.783	0.002	Sh_D
Mullus surmuletus	0.008	0.012	0.626	0.137	1.064	0.833	0.008	Sh_D
Microchirus ocellatus	0.006	0.009	0.604	0	0.952	0.902	0.001	Sh_D
Equulites klunzingeri	0.033	0.019	1.716	5.082	1.784	0.051	0.001	Sh_I
Mullus barbatus	0.03	0.019	1.538	3.973	1.029	0.098	0.004	Sh_I
Sphyraena chrysotaenia	0.029	0.009	3.062	0.233	3.277	0.143	0.001	Sh_I
Citharus linguatula	0.027	0.017	1.593	1.417	3.936	0.185	0.001	Sh_I
Solea solea	0.026	0.015	1.758	2.875	0	0.226	0.001	Sh_I
Pagellus erythrinus	0.024	0.019	1.273	2.758	0	0.264	0.02	Sh_I

Continued

Table A11 continued

Species	average	sd	ratio	ava	avb	cumsum	p	stat
Callionymus filamentosus	0.023	0.015	1.514	2.592	0	0.299	0.001	Sh_I
Epinephelus aeneus	0.022	0.019	1.198	2.722	0.91	0.334	0.009	Sh_I
Chelidonichthys lucerna	0.021	0.017	1.246	1.599	2.923	0.368	0.002	Sh_I
Upeneus pori	0.021	0.015	1.411	2.67	0.66	0.401	0.003	Sh_I
Trachurus trachurus	0.021	0.016	1.338	0.817	2.66	0.434	0.003	Sh_I
Argyrosomus regius	0.021	0.021	0.999	2.275	1.01	0.467	0.043	Sh_I
Stephanolepis diaspros	0.019	0.017	1.135	2.273	0	0.497	0.022	Sh_I
Diplodus annularis	0.018	0.018	1.036	2.146	0	0.526	0.034	Sh_I
Boops boops	0.016	0.016	1.01	0.707	1.775	0.551	0.035	Sh_I
Equulites klunzingeri	0.04	0.01	3.902	5.082	0	0.053	0.001	Sh_W
Dentex macrophthalmus	0.038	0.01	3.825	0	4.774	0.104	0.002	Sh_W
Upeneus moluccensis	0.033	0.012	2.647	4.105	0	0.148	0.006	Sh_W
Chelidonichthys lastoviza	0.03	0.011	2.745	0.114	3.821	0.188	0.004	Sh_W
Saurida lessepsianus	0.028	0.022	1.258	5.241	2.121	0.224	0.011	Sh_W
Serranus cabrilla	0.025	0.009	2.652	0.62	3.481	0.257	0.021	Sh_W
Spicara maena	0.024	0.008	2.778	0.231	3.092	0.288	0.03	Sh_W
Solea solea	0.023	0.013	1.687	2.875	0	0.318	0.003	Sh_W
Stephanolepis diaspros	0.021	0.017	1.27	2.273	4.662	0.346	0.039	Sh_W
Callionymus filamentosus	0.02	0.013	1.46	2.592	0	0.426	0.02	Sh_W
Macroramphosus scolopax	0.017	0.018	0.968	0.134	1.893	0.497	0.043	Sh_W
Trachinus draco	0.016	0.016	0.993	0.109	2.337	0.582	0.036	Sh_W
Dentex dentex	0.013	0.014	0.979	0	2.01	0.715	0.034	Sh_W
Microlipophrys dalmatinus	0.009	0.009	0.979	0	1.321	0.873	0.034	Sh_W

Table A12. The top 15 species of the highest biomass in spring 2022 (CPUA = Catch per unit area in kg/km^2, % = percentage biomass).

Shallow			Deep		
CPUA (kg/km^2)	**%**	**Species**	**CPUA (kg/km2)**	**%**	**Species**
5274.77	90.8	*Pomadasys stridens*	249.49	39	*Pomadasys stridens*
110.26	1.9	*Saurida lessepsianus*	166.87	26.1	*Mullus barbatus*
85.64	1.5	*Equulites klunzingeri*	49.39	7.7	*Epinephelus aeneus*
40.62	0.7	*Sphyraena chrysotaenia*	49	7.7	*Saurida lessepsianus*
40.09	0.7	*Argyrosomus regius*	23.3.3	3.6	*Fistularia petimba*
37.9	0.7	*Pagellus acarne*	14.32	2.2	*Nemipterus randalli*
32.6	0.6	*Nemipterus randalli*	11.43	1.8	*Lepidotrigla cavillone*
21.23	0.4	*Mullus barbatus*	8.72	1.4	*Pagellus acarne*
17.83	0.3	*Sillago suezensis*	7.96	1.2	*Pagellus erythrinus*
17.76	0.3	*Sparus aurata*	6.32	1	*Citharus linguatula*
15.09	0.3	*Pelates quadrilineatus*	5.91	0.9	*Fistularia commersonii*
14.92	0.3	*Chelon auratus*	5.02	0.8	*Ostorhinchus fasciatus*
11.77	0.2	*Trachurus mediterraneus*	3.97	0.6	*Chelidonichthys lastoviza*
8.54	0.1	*Fistularia petimba*	3.78	0.6	*Serranus cabrilla*
8.53	0.1	*Lithognathus mormyrus*	3.11	0.5	*Upeneus moluccensis*
Limonlu			Eastern coast		
CPUA (kg/km2)	%	*Species*	CPUA (kg/km2)	%	Species
240.45	54	*Saurida lessepsianus*	74.68	55.6	*Upeneus pori*
68.73	15.4	*Pomadasys stridens*	21.04	15.6	*Nemipterus randalli*
40.62	9.1	*Nemipterus randalli*	14.02	10.4	*Trachurus mediterraneus*
27.2	6.1	*Epinephelus aeneus*	11.21	8.3	*Caranx rhonchus*
26.11	5.9	*Diplodus sargus*	3.51	2.6	*Pagellus erythrinus*
15.78	3.5	*Lagocephalus suezensis*	3.51	2.6	*Pagrus pagrus*
8.52	1.9	*Arnoglossus laterna*	2.1	1.6	*Equulites klunzingeri*
6.17	1.4	*Chelidonichthys lucerna*	2.1	1.6	*Callionymus maculatus*
4.9	1.1	*Callionymus filamentosus*	1.05	0.8	*Arnoglossus laterna*
3.26	0.7	*Pelates quadrilineatus*	0.7	0.5	*Chelidonichthys lucerna*
1.99	0.4	*Fistularia petimba*	0.49	0.4	*Torquigener flavimaculosus*
0.54	0.1	*Echelus myrus*	NA	NA	NA
0.36	0.1	*Bothus podas*	NA	NA	NA
0.18	0	*Ostorhinchus fasciatus*	NA	NA	NA
0.07	0	*Phycis phycis*	NA	NA	NA
West of Mersin Bay					
CPUA (kg/km2)	%	*Species*			
61.51	14	*Diplodus vulgaris*			
41.04	9.3	*Epinephelus aeneus*			
37.63	8.6	*Upeneus pori*			
25.25	5.8	*Pagellus acarne*			
25.11	5.7	*Lagocephalus suezensis*			
23	5.2	*Parupeneus forsskali*			
20.61	4.7	*Diplodus annularis*			
18.42	4.2	*Fistularia petimba*			
15.97	3.6	*Serranus scriba*			
14.31	3.3	*Equulites klunzingeri*			
14.07	3.2	*Saurida lessepsianus*			
12.56	2.9	*Pagellus erythrinus*			
12.32	2.8	*Siganus rivulatus*			
11.56	2.6	*Bothus podas*			
10.85	2.5	*Scorpaena scrofa*			

Table A13. Similarity percentage analysis results showing the significant average contribution of each species to the average dissimilarity between observations from the two groups in spring 2022.

Species	average	sd	ratio	ava	avb	cumsum	p	stat
Pomadasys stridens	0.038	0.018	2.154	1.272	5.917	0.053	0.001	D_Sh
Sparus aurata	0.028	0.014	2.009	0.288	3.704	0.092	0.001	D_Sh
Equulites klunzingeri	0.023	0.018	1.248	0.454	2.999	0.124	0.002	D_Sh
Fistularia petimba	0.02	0.017	1.188	2.571	0.815	0.18	0.013	D_Sh
Lepidotrigla cavillone	0.02	0.015	1.386	2.643	0.161	0.152	0.001	D_Sh
Torquigener hypselogeneion	0.018	0.012	1.489	2.991	1.123	0.233	0.001	D_Sh
Pagellus erythrinus	0.018	0.013	1.352	2.866	1.278	0.258	0.008	D_Sh
Upeneus moluccensis	0.017	0.014	1.199	2.522	1.633	0.378	0.042	D_Sh
Sphyraena chrysotaenia	0.017	0.017	0.954	0.258	2.189	0.401	0.007	D_Sh
Chelidonichthys lastoviza	0.017	0.014	1.222	2.243	0	0.33	0.001	D_Sh
Trachurus mediterraneus	0.017	0.014	1.213	0.48	2.369	0.282	0.002	D_Sh
Caranx rhonchus	0.017	0.016	1.108	0	2.19	0.354	0.002	D_Sh
Trichiurus lepturus	0.017	0.015	1.116	0	2.197	0.306	0.001	D_Sh
Ostorhinchus fasciatus	0.016	0.013	1.255	2.745	1.511	0.424	0.025	D_Sh
Citharus linguatula	0.016	0.015	1.051	1.975	0.613	0.49	0.005	D_Sh
Zeus faber	0.016	0.013	1.213	2.062	0.118	0.468	0.001	D_Sh
Argyrosomus regius	0.013	0.018	0.739	0	1.651	0.567	0.019	D_Sh
Serranus hepatus	0.013	0.014	0.973	1.683	0.245	0.548	0.011	D_Sh
Chelidonichthys lucerna	0.012	0.014	0.818	0.295	1.349	0.617	0.022	D_Sh
Solea solea	0.012	0.015	0.824	0	1.602	0.584	0.015	D_Sh
Spicara flexuosum	0.01	0.014	0.718	1.291	0	0.723	0.008	D_Sh
Jaydia smithi	0.006	0.01	0.58	0	0.683	0.834	0.049	D_Sh
Monochirus hispidus	0.004	0.007	0.5	0.477	0	0.91	0.029	D_Sh
Blennius ocellaris	0.004	0.007	0.511	0.506	0	0.914	0.027	D_Sh
Upeneus pori	0.028	0.014	1.966	0.265	3.801	0.039	0.001	D_W
Parupeneus forsskali	0.027	0.013	2.098	0.213	3.718	0.076	0.001	D_W
Bothus podas	0.025	0.014	1.714	0.577	3.451	0.11	0.001	D_W
Siganus rivulatus	0.021	0.014	1.525	0	2.822	0.139	0.001	D_W
Stephanolepis diaspros	0.02	0.014	1.447	0.439	2.895	0.167	0.001	D_W
Ostorhinchus fasciatus	0.02	0.011	1.813	2.745	0.22	0.249	0.004	D_W
Pteragogus trispilus	0.02	0.013	1.525	0.173	2.757	0.222	0.001	D_W
Epinephelus aeneus	0.02	0.018	1.105	0.417	2.481	0.195	0.013	D_W
Lepidotrigla cavillone	0.019	0.013	1.456	2.643	0	0.276	0.011	D_W
Saurida lessepsianus	0.018	0.015	1.181	4.567	2.312	0.376	0.002	D_W
Lagocephalus suezensis	0.018	0.016	1.106	0.826	2.332	0.425	0.013	D_W
Upeneus moluccensis	0.018	0.013	1.426	2.522	0.606	0.351	0.046	D_W
Serranus cabrilla	0.018	0.015	1.226	1.299	2.753	0.327	0.003	D_W
Pterois miles	0.017	0.014	1.217	1.4	2.682	0.471	0.015	D_W
Chelidonichthys lastoviza	0.015	0.012	1.221	2.243	0.875	0.536	0.047	D_W

Continued

Table A13 continued

Species	average	sd	ratio	ava	avb	cumsum	p	stat
Zeus faber	0.015	0.012	1.246	2.062	0.319	0.576	0.033	D_W
Coris julis	0.013	0.012	1.122	0	1.765	0.649	0.001	D_W
Equulites popei	0.012	0.015	0.768	0.828	1.149	0.683	0.031	D_W
Apogonichthyoides nigripinnis	0.01	0.012	0.849	0	1.447	0.726	0.001	D_W
Spicara smaris	0.009	0.012	0.781	0.678	0.966	0.739	0.032	D_W
Serranus scriba	0.008	0.014	0.615	0	1.222	0.751	0.003	D_W
Spondyliosoma cantharus	0.007	0.011	0.623	0	1.024	0.814	0.003	D_W
Symphodus tinca	0.007	0.011	0.623	0	1.024	0.824	0.003	D_W
Lagocephalus sceleratus	0.005	0.011	0.402	0	0.566	0.881	0.006	D_W
Diplodus vulgaris	0.005	0.013	0.403	0	0.805	0.875	0.011	D_W
Scorpaena porcus	0.004	0.011	0.403	0	0.665	0.887	0.011	D_W
Symphodus mediterraneus	0.004	0.01	0.403	0	0.574	0.921	0.011	D_W
Muraena helena	0.004	0.011	0.403	0	0.595	0.905	0.007	D_W
Sparisoma cretense	0.004	0.011	0.403	0	0.665	0.893	0.011	D_W
Symphodus roissali	0.004	0.01	0.403	0	0.576	0.916	0.011	D_W
Xyrichtys novacula	0.004	0.01	0.403	0	0.534	0.911	0.005	D_W
Callionymus maculatus	0.004	0.008	0.479	0.162	0.405	0.932	0.033	D_W
Jaydia queketti	0.003	0.007	0.402	0	0.362	0.958	0.006	D_W
Gobius niger	0.003	0.007	0.403	0	0.362	0.965	0.005	D_W
Engraulis encrasicolus	0.002	0.005	0.403	0	0.263	0.984	0.005	D_W
Pomadasys stridens	0.033	0.014	2.358	5.917	1.118	0.042	0.006	Sh_W
Parupeneus forsskali	0.026	0.012	2.136	0.152	3.718	0.106	0.001	Sh_W
Sparus aurata	0.026	0.01	2.547	3.704	0	0.074	0.002	Sh_W
Bothus podas	0.023	0.012	1.973	0.302	3.451	0.135	0.001	Sh_W
Upeneus pori	0.021	0.015	1.409	1.318	3.801	0.161	0.009	Sh_W
Stephanolepis diaspros	0.02	0.013	1.523	0	2.895	0.186	0.001	Sh_W
Serranus cabrilla	0.02	0.013	1.5	0	2.753	0.235	0.001	Sh_W
Pteragogus trispilus	0.019	0.013	1.509	0	2.757	0.258	0.001	Sh_W
Siganus rivulatus	0.019	0.013	1.441	0.383	2.822	0.281	0.003	Sh_W
Saurida lessepsianus	0.018	0.014	1.251	4.592	2.312	0.327	0.003	Sh_W
Pterois miles	0.018	0.013	1.401	0.214	2.682	0.304	0.004	Sh_W
Torquigener hypselogeneion	0.016	0.012	1.433	1.123	3.028	0.414	0.014	Sh_W
Lagocephalus suezensis	0.016	0.015	1.092	0.721	2.332	0.434	0.045	Sh_W
Coris julis	0.012	0.011	1.12	0	1.765	0.609	0.001	Sh_W
Apogonichthyoides nigripinnis	0.01	0.011	0.848	0	1.447	0.689	0.005	Sh_W
Serranus scriba	0.008	0.013	0.614	0	1.222	0.785	0.029	Sh_W
Spondyliosoma cantharus	0.007	0.011	0.623	0	1.024	0.82	0.029	Sh_W
Symphodus tinca	0.007	0.011	0.623	0	1.024	0.828	0.029	Sh_W

Table A14. The top 15 species of the highest biomass in autumn 2022 (CPUA = Catch per unit area in g/km^2, % = percentage biomass).

Shallow			**Deep**		
CPUA (kg/km2)	**%**	**Species**	**CPUA (kg/km2)**	**%**	**Species**
2899.69	70.2	*Pomadasys stridens*	4299474.736	40.3	*Mullus barbatus*
526.86	12.8	*Equulites klunzingeri*	1446024.758	13.6	*Pagellus acarne*
152.99	3.7	*Saurida lessepsianus*	799024.0446	7.5	*Saurida lessepsianus*
152.56	3.7	*Mullus barbatus*	706632.819	6.6	*Pagellus erythrinus*
67.03	1.6	*Upeneus moluccensis*	671641.0206	6.3	*Upeneus moluccensis*
53.56	1.3	*Argyrosomus regius*	376546.1947	3.5	*Nemipterus randalli*
38.91	0.9	*Pagellus erythrinus*	266472.3538	2.5	*Champsodon nudivittis*
37.16	0.9	*Nemipterus randalli*	255841.1861	2.4	*Etrumeus golanii*
36.45	0.9	*Sillago suezensis*	254217.2899	2.4	*Boops boops*
18.87	0.5	*Sparus aurata*	222855.1515	2.1	*Fistularia petimba*
15.97	0.4	*Upeneus pori*	165778.605	1.6	*Citharus linguatula*
13.61	0.3	*Lagocephalus suezensis*	88196.2849	0.8	*Chelidonichthys lastoviza*
13.07	0.3	*Trichiurus lepturus*	84184.098	0.8	*Trachurus mediterraneus*
11.32	0.3	*Trachurus mediterraneus*	73497.4623	0.7	*Serranus hepatus*
10.86	0.3	*Lagocephalus spadiceus*	71872.93705	0.7	*Pomadasys stridens*
Deep in east			West of Mersin Bay		
CPUA (kg/km2)	%	Species	CPUA (kg/km2)	%	Species
83316.08628	35.6	*Nemipterus randalli*	1439763.757	37.4	*Mullus barbatus*
65429.01691	28	*Saurida lessepsianus*	433267.7039	11.3	*Epinephelus aeneus*
42364.11167	18.1	*Upeneus moluccensis*	271127.177	7.1	*Equulites kluzingeri*
15062.79526	6.4	*Champsodon nudivittis*	239586.5247	6.2	*Fistularia petimba*
8472.822334	3.6	*Fistularia petimba*	173223.1653	4.5	*Dentex gibbosus*
4471.767343	1.9	*Diplodus annularis*	149536.3591	3.9	*Upeneus pori*
4001.054991	1.7	*Jaydia smithi*	141813.4264	3.7	*Saurida lessepsianus*
3294.986463	1.4	*Pagellus erythrinus*	137514.6077	3.6	*Parupeneus forsskali*
2824.274111	1.2	*Equulites klunzingeri*	123370.8049	3.2	*Pagellus erythrinus*
1647.493232	0.7	*Jaydia queketti*	73831.76737	1.9	*Upeneus moluccensis*
1176.78088	0.5	*Citharus linguatula*	70885.86523	1.8	*Siganus rivulatus*
941.4247038	0.4	*Lagocephalus spadiceus*	68684.35502	1.8	*Pagellus acarne*
470.7123519	0.2	*Equulites popei*	62323.1801	1.6	*Lagocephalus suezensis*
235.3561759	0.1	*Pomadasys stridens*	56276.12087	1.5	*Pomadasys stridens*
NA	NA	NA	53307.87702	1.4	*Pteragogus trispilus*
X					
CPUA (kg/km2)	%	Species			
307538.116	23.8	*Pomadasys stridens*			
173702.084	13.4	*Serranus scriba*			
130276.563	10.1	*Epinephelus aeneus*			
125293.3065	9.7	*Parupeneus forsskali*			

Continued

Table A14 continued

Shallow			Deep
110699.4839	8.6	*Sparisoma cretense*	
106784.068	8.3	*Muraena helena*	
83291.57307	6.4	*Pterois miles*	
55527.71538	4.3	*Boops boops*	
44849.30858	3.5	*Siganus rivulatus*	
27763.85769	2.1	*Scorpaena notata*	
26696.01701	2.1	*Sargocentron rubrum*	
22068.70739	1.7	*Pteragogus trispilus*	
18153.29157	1.4	*Diplodus annularis*	
17085.45089	1.3	*Scorpaena scrofa*	
13881.92884	1.1	*Diplodus sargus*	

Table A15. Similarity percentage analysis results showing the significant average contribution of each species to the average dissimilarity between observations from the two groups in autumn 2022.

Species	average	sd	ratio	ava	avb	cumsum	p	stat
Champsodon nudivittis	0.02	0.012	1.659	3.221	0	0.058	0.001	D_W
Parupeneus forsskali	0.02	0.009	2.238	0	3.459	0.029	0.001	D_W
Pagellus acarne	0.02	0.012	1.655	3.624	0.691	0.086	0.001	D_W
Nemipterus randalli	0.018	0.011	1.621	3.774	1.093	0.166	0.001	D_W
Upeneus pori	0.018	0.009	2.004	0.993	4.11	0.113	0.001	D_W
Citharus linguatula	0.018	0.011	1.624	3.346	0.632	0.14	0.001	D_W
Bothus podas	0.017	0.01	1.685	0.981	3.697	0.191	0.002	D_W
Lagocephalus suezensis	0.016	0.01	1.551	1.265	3.762	0.288	0.006	D_W
Upeneus moluccensis	0.016	0.012	1.327	4.117	1.785	0.265	0.004	D_W
Epinephelus aeneus	0.015	0.011	1.399	0	2.608	0.311	0.001	D_W
Trachurus mediterraneus	0.015	0.01	1.423	2.979	1.042	0.354	0.043	D_W
Arnoglossus laterna	0.015	0.008	1.88	2.543	0	0.333	0.001	D_W
Boops boops	0.013	0.011	1.185	2.385	1.294	0.43	0.041	D_W
Chelidonichthys lastoviza	0.013	0.012	1.126	2.328	0	0.393	0.002	D_W
Zeus faber	0.013	0.012	1.112	2.224	0	0.373	0.002	D_W
Pteragogus trispilus	0.012	0.011	1.108	0	2.102	0.467	0.002	D_W
Pterois miles	0.012	0.011	1.087	0.943	2.089	0.501	0.005	D_W
Serranus cabrilla	0.011	0.01	1.11	1.971	1.018	0.552	0.009	D_W
Sardina pilchardus	0.011	0.009	1.278	1.97	0	0.535	0.003	D_W
Synodus saurus	0.011	0.01	1.077	1.107	1.931	0.568	0.01	D_W
Stephanolepis diaspros	0.01	0.01	0.975	0.79	1.648	0.644	0.009	D_W
Dentex gibbosus	0.01	0.012	0.832	0	1.878	0.614	0.012	D_W
Spicara flexuosum	0.01	0.01	0.983	1.748	0.409	0.659	0.011	D_W
Lepidotrigla cavillone	0.01	0.011	0.913	1.754	0	0.687	0.009	D_W
Mullus surmuletus	0.01	0.01	0.987	1.738	0.529	0.629	0.012	D_W
Blennius ocellaris	0.01	0.009	1.13	1.831	0.402	0.599	0.012	D_W
Etrumeus golanii	0.009	0.01	0.905	1.683	0	0.729	0.004	D_W
Spicara smaris	0.008	0.009	0.869	1.248	0.338	0.789	0.026	D_W
Uranoscopus scaber	0.008	0.01	0.765	1.188	0.477	0.778	0.038	D_W
Chelidonichthys lucerna	0.006	0.009	0.685	1.06	0	0.809	0.028	D_W
Cheilodipterus novemstriatus	0.004	0.006	0.62	0	0.694	0.902	0.027	D_W
Pomadasys stridens	0.029	0.011	2.653	5.833	0.697	0.044	0.001	Sh_D
Equulites klunzingeri	0.029	0.008	3.447	5.6	0.482	0.087	0.001	Sh_D
Pagellus acarne	0.02	0.01	1.903	0	3.624	0.116	0.001	Sh_D
Argyrosomus regius	0.019	0.012	1.549	3.463	0.29	0.144	0.001	Sh_D
Champsodon nudivittis	0.018	0.011	1.699	0	3.221	0.172	0.001	Sh_D
Citharus linguatula	0.018	0.009	1.921	0.141	3.346	0.199	0.001	Sh_D
Serranus hepatus	0.016	0.009	1.862	0.115	2.999	0.223	0.001	Sh_D
Lagocephalus spadiceus	0.015	0.009	1.637	3.087	0.552	0.246	0.002	Sh_D

Continued

Table A15 continued

Species	average	sd	ratio	ava	avb	cumsum	p	stat
Upeneus pori	0.014	0.009	1.513	3.163	0.993	0.29	0.01	Sh_D
Torquigener hypselogeneion	0.012	0.008	1.618	0.888	2.882	0.366	0.003	Sh_D
Boops boops	0.012	0.011	1.154	0.893	2.385	0.421	0.022	Sh_D
Chelidonichthys lastoviza	0.012	0.011	1.138	0	2.328	0.384	0.001	Sh_D
Zeus faber	0.012	0.011	1.127	0	2.224	0.347	0.002	Sh_D
Arnoglossus laterna	0.012	0.008	1.621	0.483	2.543	0.402	0.001	Sh_D
Serranus cabrilla	0.011	0.009	1.136	0	1.971	0.506	0.001	Sh_D
Sardina pilchardus	0.011	0.008	1.295	0	1.97	0.522	0.001	Sh_D
Mullus surmuletus	0.01	0.01	0.982	0.179	1.738	0.629	0.007	Sh_D
Blennius ocellaris	0.01	0.009	1.135	0	1.831	0.6	0.002	Sh_D
Etrumeus golanii	0.009	0.01	0.912	0	1.683	0.683	0.001	Sh_D
Spicara flexuosum	0.009	0.01	0.937	0	1.748	0.657	0.003	Sh_D
Lepidotrigla cavillone	0.009	0.01	0.921	0	1.754	0.67	0.003	Sh_D
Spicara smaris	0.007	0.009	0.814	0	1.248	0.729	0.007	Sh_D
Engraulis encrasicolus	0.006	0.008	0.722	0.121	0.998	0.839	0.008	Sh_D
Chelidonichthys lucerna	0.006	0.008	0.69	0	1.06	0.814	0.004	Sh_D
Dentex macrophthalmus	0.004	0.006	0.572	0	0.726	0.915	0.014	Sh_D
Microchirus ocellatus	0.004	0.007	0.572	0	0.765	0.909	0.012	Sh_D
Arnoglossus thori	0.004	0.008	0.572	0	0.85	0.891	0.016	Sh_D
Hippocampus hippocampus	0.002	0.005	0.431	0	0.342	0.968	0.041	Sh_D
Argyrosomus regius	0.023	0.014	1.613	3.463	0	0.035	0.001	Sh_W
Parupeneus forsskali	0.021	0.01	2.193	0.112	3.459	0.068	0.001	Sh_W
Lagocephalus spadiceus	0.02	0.011	1.878	3.087	0	0.099	0.001	Sh_W
Nemipterus randalli	0.02	0.012	1.666	3.914	1.093	0.16	0.001	Sh_W
Sparus aurata	0.02	0.012	1.702	3.169	0	0.129	0.001	Sh_W
Upeneus moluccensis	0.019	0.013	1.406	4.659	1.785	0.189	0.001	Sh_W
Bothus podas	0.018	0.011	1.714	1.022	3.697	0.217	0.002	Sh_W
Epinephelus aeneus	0.016	0.012	1.347	0.441	2.608	0.295	0.001	Sh_W
Saurida lessepsianus	0.015	0.01	1.408	4.433	2.661	0.388	0.007	Sh_W
Dussumieria elopsoides	0.015	0.011	1.336	2.392	0	0.319	0.002	Sh_W
Trachurus mediterraneus	0.015	0.012	1.204	2.643	1.042	0.365	0.018	Sh_W
Ostorhinchus fasciatus	0.014	0.011	1.187	2.168	0.495	0.474	0.022	Sh_W
Torquigener hypselogeneion	0.014	0.009	1.541	0.888	2.762	0.453	0.002	Sh_W
Pteragogus trispilus	0.013	0.012	1.118	0	2.102	0.494	0.001	Sh_W
Pterois miles	0.013	0.012	1.094	0	2.089	0.534	0.009	Sh_W
Serranus hepatus	0.013	0.01	1.329	0.115	2.017	0.514	0.04	Sh_W
Synodus saurus	0.012	0.011	1.085	0	1.931	0.553	0.002	Sh_W
Siganus rivulatus	0.011	0.012	0.945	0.641	1.76	0.644	0.012	Sh_W
Dentex gibbosus	0.011	0.013	0.886	0.299	1.878	0.626	0.002	Sh_W
Stephanolepis diaspros	0.01	0.011	0.852	0	1.648	0.691	0.013	Sh_W

Continued

Table A15 continued

Species	average	sd	ratio	ava	avb	cumsum	p	stat
Lagocephalus sceleratus	0.009	0.009	0.937	0.604	1.136	0.762	0.015	Sh_W
Apogonichthyoides nigripinnis	0.005	0.007	0.689	0.243	0.702	0.868	0.036	Sh_W
Fistularia commersonii	0.004	0.009	0.457	0.133	0.552	0.901	0.039	Sh_W
Cheilodipterus novemstriatus	0.004	0.006	0.623	0	0.694	0.895	0.012	Sh_W

Table A16. Results of the indicator species analysis for autumn 1983.

A	Sh	D	S	W	index	stat	p.value	Species
0	1	1	0	0	10	0.226455	1	*Atherinomorus lacunosus*
0	0	0	1	0	4	0.942901	0.07	*Siganus luridus*
0	1	1	0	0	10	0.27735	0.84	*Sillago suezensis*
1	1	1	1	1	31	0.848528	NA	*Stephanolepis diaspros*
0	0	0	0	1	5	0.534572	0.332	*Lagocephalus spadiceus*
0	1	1	0	1	23	0.978945	0.004	*Saurida lessepsianus*
1	1	0	1	1	28	0.919774	0.026	*Equulites klunzingeri*
0	0	0	1	0	4	0.873871	0.072	*Pelates quadrilineatus*
0	0	0	1	0	4	0.863139	0.174	*Apogonichthyoides nigripinnis*
1	0	0	1	0	8	0.921408	0.004	*Siganus rivulatus*
0	1	1	0	0	10	0.806417	0.06	*Upeneus moluccensis*
1	1	0	0	1	18	0.742418	0.153	*Callionymus filamentosus*
0	1	1	0	0	10	0.423659	0.605	*Sphyraena chrysotaenia*
0	1	0	0	0	2	0.387298	0.285	*Scyris alexandrina*
0	1	0	0	0	2	0.223607	1	*Seriola dumerili*
0	1	1	0	0	10	0.392232	0.61	*Engraulis encrasicolus*
1	1	0	0	0	6	0.736416	0.157	*Diplodus annularis*
0	0	1	0	0	3	0.345714	0.487	*Echelus myrus*
0	0	1	0	1	14	0.654654	0.429	*Scorpaena porcus*
0	1	0	0	0	2	0.774597	0.206	*Pomadasys incisus*
0	1	0	0	0	2	0.387298	0.31	*Pomatomus saltatrix*
0	1	1	0	1	23	0.5	1	*Boops boops*
1	0	1	1	0	19	0.815805	0.028	*Spicara maena*
0	0	1	0	0	3	0.512989	0.206	*Cepola macrophthalma*
0	1	0	0	0	2	0.223607	1	*Serranus cabrilla*
0	0	1	0	1	14	0.89176	0.001	*Citharus linguatula*
0	0	0	1	0	4	0.891405	0.12	*Diplodus vulgaris*
0	0	1	0	0	3	0.282245	0.537	*Chelidonichthys lastoviza*
0	0	0	0	1	5	0.666667	0.143	*Dentex dentex*
0	1	0	0	0	2	0.387298	0.294	*Dentex gibbosus*
0	0	0	0	1	5	0.333333	0.231	*Dactylopterus volitans*
0	1	1	0	1	23	0.889757	0.061	*Gobius niger*
0	1	0	0	1	12	0.491304	0.298	*Epinephelus aeneus*

Continued

Table A16 continued

A	Sh	D	S	W	index	stat	p.value	Species
0	1	1	1	1	30	0.92582	0.29	*Chelidonichthys lucerna*
0	0	1	0	0	3	0.688247	0.347	*Merluccius merluccius*
0	1	0	0	0	2	0.447214	0.208	*Caranx rhonchus*
0	1	1	1	0	22	0.718163	0.303	*Trachurus trachurus*
0	0	1	0	1	14	0.731925	0.303	*Zeus faber*
0	0	1	0	1	14	0.954662	0.001	*Lepidotrigla cavillone*
0	1	1	0	0	10	0.392232	0.576	*Trichiurus lepturus*
0	0	0	1	0	4	0.789921	0.12	*Argyrosomus regius*
0	0	1	0	0	3	0.324443	0.253	*Microchirus ocellatus*
0	1	1	1	1	30	0.979379	0.121	*Arnoglossus laterna*
1	0	0	1	0	8	0.826949	0.052	*Mullus surmuletus*
1	1	1	1	1	31	0.969536	NA	*Mullus barbatus*
0	0	1	0	0	3	0.700129	0.442	*Blennius ocellaris*
1	0	0	0	1	9	0.789129	0.096	*Bothus podas*
1	1	1	0	1	27	0.936777	0.26	*Pagellus erythrinus*
0	1	0	0	0	2	0.223607	1	*Remora remora*
0	0	0	0	1	5	0.809529	0.064	*Pagrus pagrus*
0	0	1	0	0	3	0.229416	0.587	*Scorpaena scrofa*
0	0	0	1	0	4	0.896388	0.091	*Sardinella aurita*
0	0	1	0	0	3	0.399774	0.412	*Pagellus acarne*
1	0	0	1	0	8	0.803756	0.073	*Sparus aurata*
0	0	0	1	0	4	1	0.051	*Oblada melanurus*
0	0	0	0	1	5	0.471405	0.104	*Diplodus cervinus*
0	0	1	0	1	14	0.5	0.3	*Synodus saurus*
0	1	1	1	0	22	0.791453	0.031	*Solea solea*
0	1	1	0	1	23	0.866025	0.081	*Serranus hepatus*
1	0	0	1	0	8	0.946951	0.006	*Lithognathus mormyrus*
0	0	0	1	0	4	0.909522	0.042	*Diplodus sargus*
0	1	0	0	1	12	0.557086	0.346	*Balistes capriscus*
0	0	1	0	1	14	0.81105	0.05	*Uranoscopus scaber*
0	0	1	0	1	14	0.327327	0.389	*Scomber colias*
0	0	1	0	1	14	0.498932	0.514	*Trachinus draco*
0	1	0	0	0	2	0.223607	1	*Xyrichtys novacula*

Table A17. Results of the indicator species analysis for spring 1984.

A	Cd	Ec	Mc	W	index	stat	p.value	Species
0	0	1	0	0	3	1	0.061	*Sillago suezensis*
0	0	1	0	1	14	0.932404	0.011	*Stephanolepis diaspros*
0	0	0	0	1	5	0.448043	0.348	*Lagocephalus spadiceus*
0	1	0	0	1	12	0.98165	0.002	*Saurida lessepsianus*
0	1	0	0	0	2	0.140028	1	*Alepes djedaba*
1	0	1	0	0	7	0.877848	0.121	*Equulites klunzingeri*
0	0	1	0	0	3	0.98483	0.055	*Pelates quadrilineatus*
0	0	1	0	0	3	0.808091	0.315	*Apogonichthyoides nigripinnis*
0	0	1	0	0	3	0.895988	0.103	*Siganus rivulatus*
0	0	1	0	0	3	0.769653	0.511	*Upeneus pori*
0	1	0	0	0	2	0.863191	0.204	*Upeneus moluccensis*
0	1	0	0	0	2	0.542326	0.813	*Callionymus filamentosus*
0	1	0	0	0	2	0.342997	1	*Sphyraena chrysotaenia*
0	0	0	1	0	4	0.994512	0.049	*Engraulis encrasicolus*
0	0	1	0	1	14	0.84774	0.292	*Diplodus annularis*
0	1	0	0	0	2	0.370479	1	*Echelus myrus*
0	0	0	0	1	5	0.414137	0.768	*Scorpaena porcus*
0	0	0	1	0	4	0.993138	0.049	*Pomadasys incisus*
0	1	0	0	0	2	0.140028	1	*Pomatomus saltatrix*
0	1	0	0	1	12	0.603023	1	*Boops boops*
1	1	0	1	1	28	0.917663	0.484	*Spicara maena*
0	1	0	0	0	2	0.140028	1	*Spondyliosoma cantharus*
0	1	0	0	0	2	0.313112	1	*Cepola macrophthalma*
0	0	0	0	1	5	0.752994	0.606	*Serranus cabrilla*
0	1	0	0	1	12	0.873863	0.242	*Citharus linguatula*
0	0	0	1	0	4	1	0.054	*Umbrina cirrosa*
0	1	0	0	0	2	0.140028	1	*Conger conger*
0	0	1	1	1	25	0.988352	0.001	*Diplodus vulgaris*
0	0	0	0	1	5	0.879745	0.133	*Chelidonichthys lastoviza*
0	0	0	0	1	5	0.707107	0.106	*Dentex dentex*
0	1	0	0	0	2	0.140028	1	*Dentex macrophthalmus*
0	0	0	0	1	5	0.639768	0.366	*Dentex gibbosus*
0	1	1	1	0	22	0.890198	0.195	*Gobius niger*
0	1	0	0	0	2	0.140028	1	*Epinephelus marginatus*
0	1	0	0	0	2	0.242536	1	*Epinephelus aeneus*
1	1	1	0	1	27	0.878595	0.7	*Chelidonichthys lucerna*
0	1	0	0	0	2	0.685994	0.853	*Merluccius merluccius*
1	0	1	0	0	7	0.90824	0.038	*Trachurus trachurus*
0	1	0	0	0	2	0.19803	1	*Hippocampus hippocampus*
0	1	0	0	1	12	0.750757	0.816	*Zeus faber*

Continued

Table A17 continued

A	Cd	Ec	Mc	W	index	stat	p.value	Species
0	1	0	1	1	24	0.834523	0.64	*Lepidotrigla cavillone*
0	0	0	1	0	4	0.98405	0.05	*Trichiurus lepturus*
0	0	0	1	0	4	0.993697	0.049	*Argyrosomus regius*
0	1	0	0	0	2	0.140028	1	*Monochirus hispidus*
0	1	0	0	0	2	0.242536	1	*Microchirus ocellatus*
1	1	0	1	1	28	0.991189	0.114	*Arnoglossus laterna*
0	0	1	0	0	3	1	0.061	*Mugil cephalus*
0	0	0	0	1	5	0.989856	0.002	*Mullus surmuletus*
0	1	0	0	1	12	0.873863	0.229	*Mullus barbatus*
0	1	0	0	0	2	0.542326	0.796	*Blennius ocellaris*
0	0	0	0	1	5	0.916636	0.068	*Bothus podas*
0	1	0	0	1	12	0.904534	0.159	*Pagellus erythrinus*
0	0	0	0	1	5	0.966303	0.021	*Pagrus pagrus*
0	0	0	0	1	5	0.634347	0.39	*Scorpaena scrofa*
0	1	0	0	0	2	0.19803	1	*Sardinella aurita*
0	0	1	0	0	3	0.81667	0.394	*Pagellus acarne*
0	0	1	0	0	3	0.876213	0.282	*Sparus aurata*
0	0	1	0	0	3	1	0.061	*Diplodus cervinus*
0	1	0	0	0	2	0.342997	1	*Synodus saurus*
0	1	0	0	0	2	0.140028	1	*Syngnathus acus*
0	0	0	0	1	5	0.960598	0.036	*Scorpaena notata*
0	1	0	0	0	2	0.280056	1	*Macroramphosus scolopax*
0	1	1	1	1	30	0.878595	0.696	*Solea solea*
0	1	0	0	1	12	0.76277	0.819	*Serranus hepatus*
0	0	1	0	0	3	0.876471	0.235	*Lithognathus mormyrus*
0	0	0	0	1	5	0.5	0.117	*Diplodus sargus*
0	1	0	0	0	2	0.140028	1	*Balistes capriscus*
0	1	0	0	1	12	0.738549	0.833	*Uranoscopus scaber*
0	1	0	0	1	12	0.486172	1	*Trachinus draco*
0	0	0	0	1	5	0.482825	0.182	*Xyrichtys novacula*

Table A18. Results of the indicator species analysis for autumn 1984.

Sh	D	I	W	Wc	index	stat	p.value	Species
0	0	0	0	1	5	0.954215	0.023	*Siganus luridus*
1	0	0	0	0	1	0.534522	0.36	*Sillago suezensis*
0	0	0	1	1	15	0.857374	0.005	*Stephanolepis diaspros*
1	0	0	0	0	1	0.681385	0.297	*Lagocephalus spadiceus*
1	1	1	1	0	26	0.972846	0.064	*Saurida lessepsianus*
1	0	1	0	1	20	0.94089	0.001	*Equulites klunzingeri*
1	0	0	0	0	1	0.46291	0.352	*Pelates quadrilineatus*
1	0	0	0	0	1	0.46291	0.338	*Apogonichthyoides nigripinnis*
0	0	0	1	1	15	0.7129	0.204	*Siganus rivulatus*
1	0	1	1	0	19	0.808964	0.047	*Upeneus pori*
1	1	1	0	0	16	0.922958	0.003	*Upeneus moluccensis*
1	0	0	0	0	1	0.732351	0.173	*Callionymus filamentosus*
0	0	1	0	0	3	0.947308	0.001	*Sphyraena chrysotaenia*
1	0	0	0	0	1	0.46291	0.333	*Scyris alexandrina*
1	0	0	0	0	1	0.286558	0.64	*Engraulis encrasicolus*
1	0	0	0	0	1	0.731925	0.172	*Diplodus annularis*
1	1	0	0	0	6	0.2	1	*Echelus myrus*
0	1	0	1	0	11	0.718697	0.213	*Scorpaena porcus*
1	0	0	0	0	1	0.681385	0.272	*Pomadasys incisus*
1	0	0	0	0	1	0.188982	1	*Pomatomus saltatrix*
0	1	1	0	0	10	0.560753	0.586	*Boops boops*
0	1	0	1	0	11	0.850162	0.016	*Spicara maena*
0	1	0	0	0	2	0.369274	0.386	*Cepola macrophthalma*
0	0	0	1	0	4	0.750064	0.12	*Serranus cabrilla*
0	1	1	0	0	10	0.926445	0.001	*Citharus linguatula*
1	0	0	0	0	1	0.46291	0.332	*Umbrina cirrosa*
0	1	0	0	0	2	0.257053	0.645	*Conger conger*
1	1	0	0	0	6	0.374166	0.88	*Diplodus vulgaris*
0	0	0	1	1	15	0.863812	0.011	*Chelidonichthys lastoviza*
0	0	0	1	0	4	0.707107	0.049	*Microlipophrys dalmatinus*
0	0	0	0	1	5	0.839383	0.031	*Dentex dentex*
0	0	0	1	1	15	0.947809	0.003	*Dentex macrophthalmus*
0	0	0	0	1	5	0.897072	0.021	*Dentex gibbosus*
1	1	0	0	0	6	0.2	1	*Dactylopterus volitans*
1	1	1	0	0	16	0.827759	0.114	*Gobius niger*
1	0	1	0	0	7	0.770552	0.085	*Epinephelus aeneus*
0	1	1	1	0	22	0.749955	0.231	*Chelidonichthys lucerna*
0	1	0	0	0	2	0.766413	0.103	*Merluccius merluccius*
1	0	0	0	0	1	0.188982	1	*Caranx rhonchus*
0	0	1	0	0	3	0.649684	0.39	*Trachurus trachurus*

Continued

Table A18 continued

Sh	D	I	W	Wc	index	stat	p.value	Species
0	1	0	0	0	2	0.255476	0.739	*Hippocampus hippocampus*
0	1	0	1	0	11	0.755614	0.148	*Zeus faber*
0	1	1	0	0	10	0.885636	0.002	*Lepidotrigla cavillone*
1	1	1	0	0	16	0.471405	0.963	*Trichiurus lepturus*
1	0	1	0	0	7	0.684653	0.287	*Argyrosomus regius*
1	1	0	0	0	6	0.447214	0.818	*Monochirus hispidus*
0	1	0	0	0	2	0.522233	0.294	*Microchirus ocellatus*
1	1	1	1	0	26	0.935414	0.166	*Arnoglossus laterna*
0	0	0	0	1	5	0.883958	0.043	*Mullus surmuletus*
1	1	1	1	0	26	0.896421	0.259	*Mullus barbatus*
0	1	0	0	0	2	0.852803	0.019	*Blennius ocellaris*
0	0	0	0	1	5	0.766393	0.131	*Bothus podas*
1	1	0	1	1	28	0.890198	0.009	*Pagellus erythrinus*
0	0	0	0	1	5	0.930121	0.05	*Pagrus auriga*
1	0	0	0	0	1	0.188982	1	*Remora remora*
0	0	0	0	1	5	1	0.016	*Pagrus pagrus*
0	0	0	0	1	5	0.837847	0.06	*Scorpaena scrofa*
0	0	1	0	0	3	0.434266	0.242	*Sardinella aurita*
0	1	0	0	0	2	0.583644	0.206	*Pagellus acarne*
0	0	0	0	1	5	0.862687	0.015	*Sparus aurata*
0	0	0	0	1	5	0.787832	0.09	*Synodus saurus*
0	1	0	0	0	2	0.213201	0.499	*Syngnathus acus*
1	0	0	0	0	1	0.188982	1	*Diplodus puntazzo*
0	1	0	0	0	2	0.213201	0.505	*Scorpaena notata*
0	0	0	1	0	4	0.661873	0.096	*Macroramphosus scolopax*
1	1	0	0	0	6	0.761577	0.142	*Solea solea*
0	1	0	1	0	11	0.811253	0.022	*Serranus hepatus*
1	0	0	0	0	1	0.534522	0.364	*Lithognathus mormyrus*
0	0	0	0	1	5	0.974592	0.003	*Diplodus sargus*
0	0	0	0	1	5	0.849389	0.018	*Balistes capriscus*
0	1	1	1	0	22	0.71992	0.19	*Uranoscopus scaber*
0	0	0	1	0	4	0.644641	0.115	*Trachinus draco*
0	0	0	0	1	5	0.987268	0.008	*Xyrichtys novacula*

Table A19. Results of the indicator species analysis for spring 2022.

Sh	D	Ec	L	W	index	stat	p.value	Species
1	1	0	0	0	6	0.522233	0.529	*Champsodon nudivittis*
0	1	0	0	1	12	0.285557	0.927	*Fistularia commersonii*
0	1	0	1	1	24	0.790418	0.079	*Fistularia petimba*
1	0	0	0	0	1	0.229416	1	*Cheilodipterus novemstriatus*
1	0	0	0	0	1	0.561951	0.291	*Sillago suezensis*
0	0	0	0	1	5	0.787551	0.292	*Stephanolepis diaspros*
0	1	0	0	1	12	0.48795	0.274	*Equulites popeis*
1	1	0	0	0	6	0.301511	0.825	*Lagocephalus spadiceus*
0	0	0	0	1	5	0.377964	0.21	*Lagocephalus sceleratus*
1	1	0	1	1	28	0.949968	0.214	*Saurida lessepsianus*
1	1	1	1	1	31	0.872872	NA	*Nemipterus randalli*
1	1	0	0	1	18	0.5	1	*Oxyurichthys papuensis*
1	1	0	1	0	17	0.772957	0.139	*Ostorhinchus fasciatus*
0	0	0	0	1	5	0.819763	0.23	*Pteragogus pelycus*
1	0	0	1	0	8	0.904517	0.001	*Pomadasys stridens*
1	0	1	0	1	20	0.771439	0.132	*Equulites klunzingeri*
0	0	0	1	0	4	0.886552	0.047	*Pelates quadrilineatus*
0	1	0	0	1	12	0.705478	0.414	*Pterois miles*
0	0	0	0	1	5	0.654654	0.142	*Apogonichthyoides nigripinnis*
0	0	0	0	1	5	0.377964	0.21	*Jaydia queketti*
0	1	1	0	1	23	0.897352	0.002	*Torquigener hypselogeneion*
1	0	0	0	0	1	0.229416	1	*Planiliza carinata*
1	0	0	0	0	1	0.512989	0.295	*Jaydia smithi*
1	1	0	0	0	6	0.301511	0.832	*Dussumieria elopsoides*
0	0	0	0	1	5	0.883516	0.02	*Parupeneus forsskali*
0	0	0	0	1	5	0.793102	0.264	*Siganus rivulatus*
0	0	0	1	0	4	0.720934	0.366	*Lagocephalus suezensis*
0	0	1	0	1	14	0.860199	0.004	*Upeneus pori*
1	1	0	0	0	6	0.689922	0.463	*Upeneus moluccensis*
0	0	0	1	0	4	0.783492	0.268	*Callionymus filamentosus*
1	1	0	0	1	18	0.547723	1	*Cynoglossus sinusarabici*
1	0	0	0	0	1	0.650948	0.458	*Sphyraena chrysotaenia*
1	0	0	0	0	1	0.229416	1	*Scyris alexandrina*
0	0	0	0	1	5	0.377964	0.218	*Engraulis encrasicolus*
1	0	0	0	1	9	0.532491	0.645	*Diplodus annularis*
0	0	0	1	0	4	1	0.057	*Echelus myrus*
1	0	0	0	0	1	0.324443	0.48	*Engraulis maeoticus*
0	0	0	0	1	5	0.377964	0.207	*Scorpaena porcus*
1	0	0	0	0	1	0.324443	0.475	*Pomadasys incisus*
1	1	0	0	1	18	0.5	1	*Boops boops*

Continued

Table A19 continued

Sh	D	Ec	L	W	index	stat	p.value	Species
0	1	0	0	1	12	0.377964	0.388	*Spicara maena*
0	0	0	0	1	5	0.534522	0.106	*Spondyliosoma cantharus*
0	0	0	0	1	5	0.696597	0.411	*Serranus cabrilla*
1	0	0	0	0	1	0.458831	0.25	*Chelon auratus*
0	1	0	0	0	2	0.617653	0.475	*Citharus linguatula*
1	0	0	0	0	1	0.229416	1	*Umbrina cirrosa*
1	0	0	0	0	1	0.229416	1	*Conger conger*
0	0	0	0	1	5	0.755929	0.173	*Coris julis*
0	0	0	0	1	5	0.377964	0.207	*Diplodus vulgaris*
0	1	0	0	1	12	0.723747	0.372	*Chelidonichthys lastoviza*
0	0	0	0	1	5	0.330328	0.316	*Dentex gibbosus*
1	1	0	0	0	6	0.348155	0.762	*Deltentosteus quadrimaculatus*
0	1	0	0	1	12	0.534522	0.331	*Spicara flexuosum*
0	0	0	1	0	4	0.954413	0.077	*Phycis phycis*
0	0	0	0	1	5	0.377964	0.218	*Gobius niger*
0	0	0	1	0	4	1	0.057	*Phycis blennoides*
1	0	0	0	0	1	0.229416	1	*Epinephelus marginatus*
0	0	0	1	0	4	0.73568	0.365	*Epinephelus aeneus*
0	0	1	1	0	13	0.895226	0.005	*Chelidonichthys lucerna*
1	1	0	0	0	6	0.246183	1	*Merluccius merluccius*
1	0	1	0	0	7	0.778064	0.118	*Trachurus mediterraneus*
0	0	1	0	0	3	0.805613	0.073	*Caranx rhonchus*
0	1	0	0	0	2	0.267261	0.555	*Trachurus trachurus*
1	1	0	0	0	6	0.246183	1	*Hippocampus hippocampus*
0	1	0	0	0	2	0.728329	0.317	*Zeus faber*
0	1	0	0	0	2	0.820509	0.08	*Lepidotrigla cavillone*
1	0	0	0	0	1	0.760886	0.242	*Trichiurus lepturus*
1	0	0	0	0	1	0.229416	1	*Chelon saliens*
0	0	0	0	1	5	0.377964	0.207	*Symphodus mediterraneus*
1	0	0	0	0	1	0.606977	0.316	*Argyrosomus regius*
0	1	0	0	0	2	0.46291	0.23	*Monochirus hispidus*
0	0	0	0	1	5	0.377964	0.195	*Muraena helena*
0	1	0	0	0	2	0.267261	0.561	*Microchirus ocellatus*
0	0	1	1	0	13	0.868922	0.005	*Arnoglossus laterna*
1	0	0	0	0	1	0.229416	1	*Mullus surmuletus*
1	1	0	0	1	18	0.758288	0.476	*Mullus barbatus*
0	1	0	0	0	2	0.46291	0.221	*Blennius ocellaris*
0	0	0	1	1	15	0.8737	0.025	*Bothus podas*
0	1	1	0	1	23	0.767382	0.187	*Pagellus erythrinus*
1	0	0	0	0	1	0.229416	1	*Sardina pilchardus*

Continued

Table A19 continued

Sh	D	Ec	L	W	index	stat	p.value	Species
0	0	0	0	1	5	0.377964	0.207	*Sparisoma cretense*
1	0	0	0	0	1	0.229416	1	*Pagrus auriga*
0	1	0	0	0	2	0.267261	0.561	*Arnoglossus thori*
0	0	0	0	1	5	0.377964	0.207	*Symphodus roissali*
0	0	1	1	0	13	0.958188	0.004	*Pagrus pagrus*
0	0	0	0	1	5	0.49741	0.155	*Scorpaena scrofa*
1	0	0	0	0	1	0.229416	1	*Caranx crysos*
1	0	0	0	0	1	0.324443	0.389	*Sardinella aurita*
1	1	0	0	1	18	0.689202	0.735	*Pagellus acarne*
1	0	0	0	0	1	0.911152	0.001	*Sparus aurata*
1	1	0	0	1	18	0.524404	1	*Synodus saurus*
0	1	0	0	0	2	0.267261	0.538	*Scorpaena notata*
0	1	0	0	0	2	0.377964	0.228	*Macroramphosus scolopax*
1	0	0	0	1	9	0.588348	0.427	*Solea solea*
0	1	0	0	1	12	0.48795	0.298	*Spicara smaris*
0	1	0	0	1	12	0.626356	0.466	*Serranus hepatus*
0	0	0	0	1	5	0.534522	0.106	*Serranus scriba*
1	0	0	0	0	1	0.324443	0.484	*Lithognathus mormyrus*
0	0	0	1	0	4	0.886382	0.09	*Diplodus sargus*
0	0	0	0	1	5	0.534522	0.106	*Symphodus tinca*
1	0	0	0	0	1	0.229416	1	*Alosa fallax*
0	1	0	0	0	2	0.377964	0.221	*Uranoscopus scaber*
1	0	0	0	0	1	0.324443	0.499	*Scomber colias*
0	0	0	0	1	5	0.377964	0.218	*Xyrichtys novacula*
0	0	1	0	0	3	0.924256	0.099	*Callionymus maculatus*
1	0	0	0	0	1	0.39736	0.301	*Sphyraena sphyraena*

Table A20. Results of the indicator species analysis for autumn 2022.

D	Ed	Sh	W	X	index	stat	p.value	Species
1	1	0	0	0	6	0.919866211	0.001	*Champsodon nudivittis*
0	0	0	1	0	4	0.339323342	0.261	*Fistularia commersonii*
1	1	1	1	0	26	0.811502671	0.697	*Fistularia petimba*
0	0	0	0	1	5	1	0.046	*Sargocentron rubrum*
0	0	0	1	0	4	0.534522484	0.128	*Cheilodipterus novemstriatus*
0	0	0	0	1	5	0.934160034	0.083	*Siganus luridus*
0	0	1	0	0	3	0.487950036	0.31	*Sillago suezensis*
1	0	0	1	0	8	0.561951487	0.279	*Stephanolepis diaspros*
0	1	0	0	0	2	0.800023055	0.126	*Equulites popei*
0	1	1	0	0	10	0.865934083	0.003	*Lagocephalus spadiceus*
0	0	0	1	0	4	0.528992409	0.359	*Lagocephalus sceleratus*
1	1	1	1	0	26	0.937042571	0.275	*Saurida lessepsianus*
1	1	1	0	0	16	0.915994435	0.003	*Nemipterus randalli*
1	0	1	0	0	7	0.426401433	0.643	*Oxyurichthys papuensis*
1	0	1	0	0	7	0.693164237	0.464	*Ostorhinchus fasciatus*
0	0	0	0	1	5	0.820893943	0.187	*Pteragogus trispilus*
0	1	1	1	1	30	0.9635234	0.001	*Pomadasys stridens*
0	1	1	1	0	22	0.946167341	0.001	*Equulites klunzingeri*
0	0	1	0	0	3	0.654653671	0.402	*Pelates quadrilineatus*
0	0	0	0	1	5	0.786590793	0.258	*Pterois miles*
0	0	0	0	1	5	0.888769867	0.076	*Apogonichthyoides nigripinnis*
0	1	0	0	0	2	0.952732064	0.039	*Jaydia queketti*
1	0	0	1	0	8	0.87923037	0.005	*Torquigener flavimaculosus*
1	1	1	0	0	16	0.727606875	0.244	*Jaydia smithi*
1	0	1	0	0	7	0.717740563	0.278	*Dussumieria elopsoides*
0	0	0	1	1	15	0.929369072	0.008	*Parupeneus forsskali*
1	0	0	0	0	1	0.707106781	0.269	*Etrumeus golanii*
0	0	0	0	1	5	0.812128097	0.183	*Siganus rivulatus*
1	0	1	1	0	19	0.836660027	0.175	*Lagocephalus suezensis*
0	0	1	1	1	25	0.888447453	0.007	*Upeneus pori*
1	1	1	1	0	26	0.937042571	0.253	*Upeneus moluccensis*
0	0	1	1	0	13	0.630940051	0.621	*Callionymus filamentosus*
1	0	1	1	0	19	0.447213595	1	*Cynoglossus sinusarabici*
0	0	1	1	0	13	0.500474679	0.63	*Sphyraena chrysotaenia*
1	0	0	0	0	1	0.545164556	0.243	*Engraulis encrasicolus*
0	1	0	0	1	12	0.848471439	0.003	*Diplodus annularis*
1	0	0	0	0	1	0.288675135	0.511	*Echelus myrus*
1	0	1	0	0	7	0.246182982	1	*Engraulis maeoticus*
1	0	0	0	0	1	0.288675135	0.511	*Scorpaena porcus*
0	0	1	0	0	3	0.47833811	0.436	*Pomadasys incisus*

Continued

Table A20 continued

D	Ed	Sh	W	X	index	stat	p.value	Species
0	0	0	0	1	5	0.713651993	0.309	*Boops boops*
1	0	0	0	0	1	0.288675135	0.495	*Cepola macrophthalma*
1	0	0	1	0	8	0.688247202	0.373	*Serranus cabrilla*
0	0	1	0	0	3	0.3086067	0.696	*Chelon auratus*
1	1	0	0	0	6	0.868993964	0.011	*Citharus linguatula*
1	0	0	0	0	1	0.288675135	0.483	*Conger conger*
0	0	0	0	1	5	0.928037893	0.083	*Coris julis*
1	0	1	0	0	7	0.301511345	0.836	*Diplodus vulgaris*
1	0	0	0	0	1	0.763762616	0.304	*Chelidonichthys lastoviza*
0	0	0	0	1	5	0.976771061	0.05	*Dentex dentex*
1	0	0	0	0	1	0.5	0.166	*Dentex macrophthalmus*
0	0	0	1	0	4	0.608100984	0.215	*Dentex gibbosus*
1	0	0	0	0	1	0.288675135	0.502	*Deltentosteus quadrimaculatus*
1	0	0	1	0	8	0.324442842	0.366	*Dactylopterus volitans*
1	0	0	0	0	1	0.636609673	0.307	*Spicara flexuosum*
1	0	0	0	0	1	0.288675135	0.511	*Gobius niger*
0	0	0	1	1	15	0.842309154	0.096	*Epinephelus aeneus*
1	0	0	0	0	1	0.577350269	0.193	*Chelidonichthys lucerna*
1	0	0	0	0	1	0.40824829	0.194	*Merluccius merluccius*
1	0	1	1	1	29	0.811502671	0.665	*Trachurus mediterraneus*
0	0	1	1	0	13	0.534522484	0.393	*Caranx rhonchus*
1	0	0	0	0	1	0.40824829	0.177	*Hippocampus hippocampus*
1	0	0	0	0	1	0.288675135	0.503	*Hippocampus guttulatus*
1	0	0	0	0	1	0.763762616	0.305	*Zeus faber*
1	0	0	0	0	1	0.707106781	0.265	*Lepidotrigla cavillone*
1	0	1	0	0	7	0.603022689	0.549	*Trichiurus lepturus*
0	0	1	0	0	3	0.838493795	0.01	*Argyrosomus regius*
1	0	0	0	0	1	0.288675135	0.497	*Monochirus hispidus*
0	0	0	0	1	5	1	0.046	*Muraena helena*
1	0	0	0	0	1	0.5	0.166	*Microchirus ocellatus*
1	0	0	0	0	1	0.836912047	0.038	*Arnoglossus laterna*
1	0	0	0	0	1	0.596149417	0.362	*Mullus surmuletus*
1	0	1	1	0	19	0.935414347	0.033	*Mullus barbatus*
1	0	0	0	0	1	0.6915862	0.341	*Blennius ocellaris*
0	0	0	1	0	4	0.805394073	0.073	*Bothus podas*
1	1	0	1	0	17	0.863201286	0.022	*Pagellus erythrinus*
1	0	0	0	0	1	0.816496581	0.184	*Sardina pilchardus*
0	0	0	0	1	5	1	0.046	*Sparisoma cretense*
0	0	0	1	0	4	0.377964473	0.208	*Pagrus auriga*
1	0	0	0	0	1	0.5	0.154	*Arnoglossus thori*

Continued

Table A20 continued

D	Ed	Sh	W	X	index	stat	p.value	Species
0	0	0	1	0	4	0.377964473	0.226	*Symphodus roissali*
0	0	0	0	1	5	1	0.046	*Symphodus rostratus*
1	0	0	0	0	1	0.288675135	0.497	*Pagrus pagrus*
0	0	0	0	1	5	1	0.046	*Scorpaena scrofa*
0	0	1	0	0	3	0.487950036	0.297	*Caranx crysos*
0	0	0	0	1	5	0.852743606	0.151	*Sardinella aurita*
0	0	1	0	0	3	0.377964473	0.385	*Sardinella maderensis*
1	0	0	0	0	1	0.83658391	0.052	*Pagellus acarne*
1	0	1	0	0	7	0.797724035	0.025	*Sparus aurata*
1	0	0	0	0	1	0.288675135	0.502	*Pagellus bogaraveo*
1	0	0	1	0	8	0.648885685	0.337	*Synodus saurus*
0	0	0	0	1	5	1	0.046	*Syngnathus acus*
0	0	0	0	1	5	0.899033744	0.094	*Scorpaena notata*
1	0	1	1	0	19	0.418330013	1	*Solea solea*
0	0	0	0	1	5	0.825674469	0.168	*Spicara smaris*
1	0	0	1	0	8	0.878486533	0.001	*Serranus hepatus*
0	0	0	0	1	5	0.94209882	0.08	*Serranus scriba*
0	0	1	0	0	3	0.577350269	0.343	*Lithognathus mormyrus*
0	0	0	0	1	5	0.951864034	0.046	*Diplodus sargus*
0	0	0	0	1	5	1	0.046	*Symphodus tinca*
0	0	1	0	0	3	0.377964473	0.392	*Balistes capriscus*
1	0	0	0	0	1	0.288675135	0.495	*Alosa fallax*
1	0	0	1	0	8	0.512989176	0.264	*Uranoscopus scaber*
1	0	0	0	0	1	0.355680531	0.478	*Scomber colias*
0	0	0	1	0	4	0.377964473	0.199	*Xyrichtys novacula*
0	0	1	0	0	3	0.534522484	0.326	*Sphyraena sphyraena*